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## THE SIGNAL LIGHT SHOWS CLEAR

By PAUL CLOKE

*Dean of the College of Technology,* University of Maine
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In these troublesome times when all forms of human activity are being subjected to close scrutiny and criticism, education and particularly engineering education has by no means gone unscathed. With the unprecedented and extremely rapid change and development of science and industry during the past decade the engineering teacher has found himself confronted with very difficult problems and has at times been perplexed and confused about the proper course to pursue amidst such a multitude of ideas regarding the proper teaching of engineering subjects and in the selection of other subjects which should be included in an engineering curriculum. It was certainly a very far-sighted policy on the part of the Society for the Promotion of Engineering Education when they authorized the series of investigations which were completed a few years ago, as these results have certainly constituted a safe harbor in time of storm and have served well as guideposts to the engineering teachers of this country in every phase of their work.

Routine is an essential element of any scientifically developed and coördinated civilization and certainly we know now that engineering education in the United States has been scientifically developed and coördinated and that it has played a major part in the development of modern civilization. The very fact that the Society has been willing to subject itself to this frank and open investigation is *prima facie* evidence of the attitude of the engineer in approaching his problems. In fact, as I have often stated to my colleagues and students, there is no form of education at the present day which leads with greater certainty to precise, logical, and accurate thinking than that of engineering and this is evidenced on every hand by the fact that engineering graduates are succeeding in every walk of life. It would be well, therefore, for every young man in considering the career which he wishes to follow, to make a thorough study of the advantages of an engineering education. The engineering teacher, on the other hand, may look with confidence and encouragement toward the future. Evidence that engineering curricula furnish well rounded training is substantiated by the fact that the engineer functions equally well in one or all of the realms of activity of dealing with men, working with ideas, handling the materials and resources of nature, and dealing with the problems of economics. Another way of stating the same thing is to say that a cultured and educated man is one who understands and is able to deal with the civilization in which he lives. The engineer has distinguished himself, measured by any of these criteria.

# A STUDY OF GRADUATE AND UNDERGRADUATE ENROLLMENTS IN ENGINEERING FROM 1921–22 TO 1930–31, AND UNDERGRADUATE, PROFESSIONAL, AND GRADUATE DEGREES IN ENGINEERING, 1921–22 TO 1929–30

By WALTON C. JOHN

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It is the purpose of this article to call attention to the growth of graduate enrollments in engineering schools in this country and to make available comparisons of these enrollments with those which are undergraduate from 1921–22 to 1930–31. It is also possible to compare the number of graduate degrees with professional and undergraduate degrees granted by engineering schools for approximately the same decade, or 1921–22 to 1929–30.

The data of this study are based upon the special reports on engineering enrollments collected by the Division of Colleges and Professional Schools of the Office of Education and the biennial survey reports of the Office of Education. Data regarding graduate degrees in engineering were taken directly from the reports of the presidents of the institutions. In 1921–22, 135 schools of engineering made final reports on engineering enrollments; in 1925, the number of schools reporting was 143; and in 1930–31, 145 schools reported.

The records show that in 1921–22, there were 368 graduate students in engineering. In 1925–26 this number reached 1,014, and in 1930–31 it reached 2,939. The undergraduate enrollments—regular four-year engineering students—in 1921–22 was 56,649; in 1925–26 it declined to 56,299; in 1930–31 it reached the peak of 73,386.

The table shows a remarkable increase in the number of graduate students in the special fields of engineering. In civil engineering, in 1921–22, only 98 were enrolled; in 1925–26 there were 156; and in 1930–31 there were 333. In mechanical engineering in 1921–22, only 50 were enrolled; in 1925–26 there were 156; and in 1930–31 there were 343. In 1921–22 in electrical engineering there were enrolled 89; in 1925–26 there were 281; and in 1930–31, there were 790. In 1921–22 in chemical engineering, there were 68 enrolled; in 1925–26 there were 214; in 1930–31, there were 400. In mining engineering and metallurgy in 1921–22 there were 25

GRADUATE AND UNDERGRADUATE ENROLLMENTS IN ENGINEERING, 1921–22 TO 1930–31, AND UNDERGRADUATE, PROFESSIONAL AND GRADUATE DEGREES IN ENGINEERING, 1921–22 TO 1929–30

| Curricula | Years | Enrollments | | Years | Degrees | | |
|---|---|---|---|---|---|---|---|
| | | Undergraduate | Graduate | | Undergraduate | Professional | Graduate |
| Civil engineering | 1921–22 | 12,838 | 98 | 1921–22 | 1,615 | 51 | 23 |
| | 1925–26 | 12,170 | 156 | 1925–26 | 1,866 | 63 | 8 |
| | 1930–31 | 13,813 | 333 | 1929–30 | 1,977 | 87 | 20 |
| Mechanical engineering | 1921–22 | 14,453 | 50 | 1921–22 | 1,673 | 43 | 22 |
| | 1925–26 | 10,337 | 156 | 1925–26 | 1,809 | 21 | 12 |
| | 1930–31 | 15,053 | 343 | 1930–30 | 1,674 | 64 | 27 |
| Electrical engineering | 1921–22 | 13,275 | 89 | 1921–22 | 1,490 | 44 | 13 |
| | 1925–26 | 17,720 | 281 | 1925–26 | 2,246 | 71 | 17 |
| | 1930–31 | 18,565 | 790 | 1929–30 | 2,427 | 71 | 17 |
| Chemical engineering | 1921–22 | 7,054 | 68 | 1921–22 | 1,009 | 28 | 8 |
| | 1925–26 | 4,627 | 214 | 1925–26 | 741 | 4 | 5 |
| | 1930–31 | 9,154 | 400 | 1929–30 | 818 | 35 | 14 |
| Mining engineering and metallurgy | 1921–22 | 2,895 | 25 | 1921–22 | 465 | 29 | 3 |
| | 1925–26 | 1,891 | 98 | 1925–26 | 408 | 2 | 4 |
| | 1930–31 | 2,771 | 129 | 1929–30 | 235 | 35 | 10 |
| Miscellaneous and undesignated courses | 1921–22 | 6,134 | 38 | 1921–22 | 902 | 17 | 109 |
| | 1925–26 | 9,554 | 109 | 1925–26 | 826 | 34 | 221 |
| | 1930–31 | 14,030 | 944 | 1929–30 | 1,172 | 31 | 330 |
| GRAND TOTAL | 1921–22 | 56,649 | 368 | 1921–22 | 7,154 | 212 | 178 |
| | 1925–26 | 56,299 | 1,014 | 1925–26 | 7,896 | 195 | 267 |
| | 1930–31 | 73,386 | 2,939 | 1929–30 | 8,303 | 323 | 418 |

enrolled; in 1925–26 there were 98; in 1930–31 there were 129. In miscellaneous and undesignated courses in 1921–22 there were 38 enrolled; in 1925–26 there were 109; in 1930–31 there were 944.

The most significant increases in graduate enrollments appear in electrical and chemical engineering, and in the miscellaneous or undesignated group, which include such as general engineering, industrial engineering, aeronautical engineering, architectural engineering, etc.

The increase in the number of undergraduate degrees in engineering shows a relatively small increase over the decade, 7,154 first degrees in engineering having been granted in 1921–22 as against 7,896 in 1925–26 and 8,303 in 1929–30. The largest increase in undergraduate engineering degrees appears in the field of electrical engineering, ranging from 1,490 in 1921–22 to 2,246 in 1925–26, to

2,427 in 1929–30. On the whole there appears to be a decline in the number of undergraduate degrees in chemical engineering, and in mining engineering including metallurgy.

The general increase in professional engineering degrees appears to be in harmony with the trends in undergraduate enrollments. In 1921–22 there were 212 professional degrees granted; in 1925–26, 195; and in 1929–30, there were 323.

The total number of graduate degrees in engineering including only the M.S. in engineering or master's degree in engineering specified or unspecified according to specialized fields shows a remarkable growth, from 178 in 1921–22 to 267 in 1925–26, and 418 in 1929–30.

Attention is called at this point to the number of graduate degrees according to specialized curricula in the last column. Owing to the fact that a large number of institutions reported the master's degree in engineering or equivalent without naming the specialized field, it was found necessary to include these in the group "Miscellaneous," and "Undesignated Courses." In other words, the 109, 221, and 330, should in large proportion be spread throughout the sections above in civil, mechanical, electrical, chemical, mining and metallurgical engineering, as the figures given these sections are altogether too small.

In conclusion it may be said that while the growth of undergraduate enrollments and degrees has been remarkable, those of graduate enrollments and degrees have been much more remarkable for the decade indicated.

# PRESENT TRENDS WITH RESPECT TO THE MASTER'S AND PROFESSIONAL DEGREES IN ENGINEERING *

By WALTON C. JOHN

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A recent examination of an unpublished study by David T. Blose of the Office of Education on "Standards for the Master's Degree," disclosed the fact that the master's degree is becoming more significant than it has been in the past. This study, which principally features data for 1927–28, shows that for that year 11,766 master's degrees were granted in this country of which number 7,651, or 65 per cent were master of arts, 1,353, or 11 per cent master of science, 448, or 4 per cent master of business administration, and 367 or 3 per cent, were master of science in engineering.

This raised the question as to the comparative status of the master's degree in engineering with that of the professional degrees in engineering such as Civil Engineer. In view of the fact that for the entire country there has been an increase in graduate enrollments in engineering, an increase of 164 per cent between 1925–26 and 1930–31,† it was thought that figures might be obtained showing the trend in the growth of both types of advanced degrees in engineering excluding those for the doctorate. The years selected for comparison are 1925–26 and 1929–30. The data are taken from the statistical reports filled in by the colleges and universities and filed with the Office of Education.

It was found that 76 institutions made reports of sufficient detail to enable comparisons to be made with respect to type of degrees. These institutions include practically all of the larger institutions offering instruction in engineering.

In 1925–26 the 76 institutions on our list reported that they had granted, excluding doctor's degrees, 650 advanced degrees in engineering. Of these, 362 were master's degrees in engineering, or nearly 56 per cent of the total, and 288 were professional degrees in engineering, or 44 per cent.

In 1929–30 the same institutions reported that they had granted,

* Presented at the 40th annual meeting, S. P. E. E., Corvallis, Oregon, June 29–July 1, 1932.

† The total number of graduate students in engineering in 1925–26 was 1114 in 143 schools. The total number of graduate students in 1930–31 was 2939 in 145 schools.

excluding doctor's degrees, 780 advanced degrees in engineering. Of these, 422 were master's degrees in engineering or 54 per cent, and 358 were professional degrees in engineering, or 46 per cent.

It will be observed for the 76 schools that 130 more master's and professional engineering degrees were granted in 1929–30 as compared with the number granted in 1925–26, or 20 per cent more.

The increase in the number of master's degrees in engineering for the years given was 60, or 16 per cent, and the increase in the number of professional engineering degrees was 70, or 24 per cent.

It is also of interest to note that of the 76 schools, 23 report the granting of professional engineering degrees only; 15 institutions report the granting of master's degrees in engineering only; and 38 institutions report the granting of both master's and professional degrees in engineering.

### Comparison of Degrees According to Specialization

A study of the data for 1930 shows that at least 25 institutions granted the master of science degree with specification as to major field; in 1926 only 14 schools made a clear statement as to specified fields.

With respect to the professional degree of Engineer, 49 institutions gave in 1930 the field of specialization, while in 1926 only 41 schools made a clear statement as to specified fields.

It may be of interest to note the relative number of professional degrees in engineering granted for the years indicated.

| Year | Number Schools | C. E. | Number Schools | M. E. | Number Schools | E. E. | Number Schools | Ch. E. | Number Schools | E. M. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1926.... | 30 | 89 | 25 | 83 | 23 | 61 | 6 | 12 | 5 | 7 |
| 1930.... | 37 | 95 | 27 | 67 | 25 | 81 | 4 | 7 | 10 | 23 |

In 1926 the following degrees were granted—one of each type: Agricultural Engineer and Ceramic Engineer. In 1930, one of each of the following degrees were granted: Fire Protection Engineer, Architectural Engineer, Agricultural Engineer, Commercial Engineer, and 9 cases of Metallurgical Engineer.

### Summary

Coupled with the great increase in the enrollments of graduate students during the past five or six years, there also has been a substantial increase in the number of students who have received the master's degree in engineering and the professional degree in engineering.

The percentage of those receiving the master's degree in engineering is considerably greater than the percentage of those receiving the professional engineering degree. These percentages are practically the same for the two years under discussion, namely, nearly 55 per cent master's degrees and 45 per cent professional degrees.

There appears to be a loss in the number receiving the M.E. degree, and an increase in the number receiving the E.E. and E.M. degrees for the years compared in this study.

## Discussion

**Secretary Bishop**: Perhaps this may interest. At least I thought it was very interesting. Last week I was at a luncheon table with Chris McNead, and one or two others, and he said he had run across a curious thing. Two students in widely separated institutions submitted the same thesis for the doctor's degree. That may provide discussion as to how that can happen. How often does it happen? I think it is well worth checking up a bit, because in a subject not involving equipment it is quite possible for two close friends to do the same type of library work, present the same conclusions and get the same discussion, and with only the slight modifications that might be imposed by two different professors on that present the same thesis, with different titles for the two different institutions and obtain two degrees. It was a good one, and it was claimed that both students did excellent work.

**C. E. Magnusson** (University of Washington): That happens frequently in the case of doctors of philosophy, and to the detriment of one of the men, because if doctor of philosophy degrees are handled properly with institutions, degrees will not be granted if the thesis has been printed. I know of two cases where they had to start two entirely different theses because the subject they were covering happened to appear in print somewhere else before hand.

**J. H. Felgar** (University of Oklahoma): I would like to ask the question, what weight does engineering field work carry for men who are doing a piece of work in the oil field line? Would it be covered by the thesis?

**D. S. Kimball** (Cornell University): I do not remember anything in the sub reports covering that, but I do know the matter of field work and certain forms of agricultural study have long been a question with us at Cornell. Sometimes the work must be done in the field, and occasionally in engineering the question has been raised where the man had to go elsewhere to get his data, but it was not brought out to any great extent in these sub reports.

**Dean Felgar**: The difficulty with that was that the man, in

order to do that work, would have to be continued for maybe six weeks or two or three months in a field in order to get his data, and that was not credited to his work according to the graduate data.

**Dean Kimball**: Last year the graduate school of Cornell granted a special request of a student to go to Europe for his last year in some special work which he could not get in this country. That was granted with the proviso that he return to Cornell before commencement, for examination before obtaining his degree, but he was allowed to collect his data at a German university, not necessarily a German university but some German field work as well. It is my experience that a more liberal attitude is taken to field work in general. Twenty-five years ago coöperative work would have been looked at very much askance.

**H. P. Hammond** (Brooklyn Polytechnic Institute): Dr. John and I have agreed that what he has been showing here is the trend in degree practice rather than the magnitude of graduate work in engineering, and perhaps it would be well to say that the total number of graduate students in engineering was not given by this paper.

I think I remember the figures accurately. In '25–'26 there were 1,114 graduate students of engineering in the United States, and in the large engineering enrollment tabulation of the Office of Education was 2,900-odd graduate students of engineering in the United States, in other words, a trebling in a period of five years. The figures that Dr. John quoted here are merely trends in degree practice rather than the magnitude of graduate work in engineering.

**Dean Magnusson**: On that point, may I ask you to give us a little more detailed information on the graduate students as to whether they were full time or part time. I think you will find it is more than the figures represent in quantity.

In earlier years the students took one or two years of graduate work. Take, for example, the University of Pittsburgh. I think you have a large number of students who taken only a few hours of graduate work, and still they count full time students in their numbers and tabulations, while we have them on full time working for degrees that is quite a different story. In order to make our statistics comparable that should be taken into account.

**Walton C. John** (Office of Education): This deals only with people who have secured their degree. Mr. Hammond wants to bring out this point: I do not mention the total number of students in graduate work, which is a little out of proportion to the number of graduates. He seems to indicate there might be a discrepancy there, that is all.

**O. J. Ferguson** (University of Nebraska): Some questions in connection with Dean Kimball's report. There is mentioned in the outline at the close the matter of the distinction between admission to candidacy and enrollment. It seems to me that is a point that would admit of considerable advantageous discussion in the report itself. What is necessary to distinguish between the actual admission to candidacy for degree and the enrollment for the graduate work?

There is one other point that was mentioned here upon which I should like information. In connection with the master's degree, is it usual among schools to require anything comparable to a comprehensive or general examination before the granting of the degree?

**Dean Kimball**: Answering your last question, I think it is quite common that a man be required to pass a formal examination. On the other hand, it is also common to give the master's degree purely on course work. Both practices are quite common. At Cornell no advanced degrees are given without formal examination, which is open to any member of the staff. A mimeographed copy of the list of examinations is sent to every member of the university faculty, and any man attending the examination can ask any questions. No degrees are given without examination and without such notice covering major and minor degrees.

**Dean Ferguson**: The first point was the distinction made between enrollment for graduate study, and admission to candidacy for the degree. We make a distinction at Nebraska and a preliminary examination must be passed before the student, although enrolled for graduate study, is admitted for candidacy for the master's degree. I wonder if that is common.

**Dean Kimball**: We obtained no data on that. I can only give you my personal knowledge, which again would indicate a great variance. Some require preliminary examination for the doctorate, but do not for the master's. The practice of admitting a man to the graduate school, not a candidate for a degree, is quite common.

Some man might arrive at your institution with a baccalaureate degree. He wishes to do a special piece of work not concerned with a master's degree. Where there is a differentiation between the graduate tuition and undergraduate tuition there are a number of people who have to be watched very carefully. There is a great variation.

There is one thing I would stress that came in from the several reports, a great variation in topics. As a matter of fact, this is not new. Dr. Hammond brought this out and found some very interesting conditions in his study of undergraduate work which has been lying in the background since that report first came out. It is almost essential that we go on and explore this other field.

The Commissioner of Higher Education in New York state discussed the matter of degrees, which is at tremendous variance in that state. He told us of one degree given, bachelor of science in oral English, something very interesting. An old state like New York has very many interesting growths that have come up, and he is endeavoring to codify and eliminate many of these curious things which still exist, which is not an easy thing to do.

The chairman of that committee, Dean Barker, is here. He happens to be chairman of that committee of educators who is trying to advise with Dr. Horner. It seems to me that having agreed on a good study of the undergraduate work, it is almost essential that we continue and explain this other field. It has grown up unguided, and with little discussion. As Dr. John pointed out, we are going to have far more pressure for graduate work in the next few years because of economic conditions than maybe we suspect. At the present moment all the schools are crowded with graduates. It looks as though that was the next thing on the program.

**E. B. Norris** (Virginia Polytechnic Institute): I just wanted to ask Dr. John, do the professional degrees he has reported include that much larger number probably which are granted merely on the basis of professional experience, or whether this report covers only those degrees granted for actual residence study?

**Dr. John**: I do not think our statistical report differentiates the way the degrees are granted by the institution. I think the institution simply fills in the number of C.E. degrees or M.E. degrees given in a particular way, and I have tabulated that material without reference to the educational requirements.

**Dean Norris**: Of those degrees earned by resident study, the number of professional degrees would be very small?

**Dr. John**: Yes, that might be so.

# NOTES ON ENGINEERING COLLEGE DEVELOPMENT IN THE WEST *

By IVAN C. CRAWFORD

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## General

*Historical Setting.*—A proper perspective of this subject can only be obtained by passing in review, briefly at least, a few of the more important historical events related to the development of the West. For the purposes of this paper the West is considered to include Colorado, Wyoming, Montana, Idaho, Washington, Oregon, California, Nevada, Utah, Arizona, and New Mexico.

In his "History of the Northwest" George Fuller says: "The Oregon country holds a unique place in our history. . . . It is the first region on the Coast to which America made claim and the first to which title was established. It was the first to receive regular migrations from the states. It is the only region jointly occupied by Great Britain and the only territory where a provisional government has existed, supported by the citizens of both nations, fighting its own Indian war until Congress got around to organizing a territory in 1848 and landing a Governor at Oregon City in 1849."

The Lewis and Clark expedition passed over the Rockies, down the Clearwater and Snake Rivers to the Columbia, and thence to the Pacific Ocean in 1805. David Thompson surveyed the Columbia River from north of the present Canadian boundary to its mouth in 1811. The first governor of the territory of Washington was Isaac I. Stevens, a West Point graduate and an engineer officer. Governor Stevens led, in 1855, the first party of white men to pass through the area where Washington State College and the University of Idaho are now located. Captain Pike partially explored Colorado in 1906–07; he was followed by Captain Long in 1920. Fremont visited the state in 1842 and in 1844. Gold was discovered in 1850, and with the resulting rush mining settlements came into existence. The Mormon pioneers arrived in Salt Lake Basin in 1847 and established the University of Deseret in 1850, which, after giving instruction for one year, was more or less dormant until 1867.

* Presented at 40th annual meeting, S. P. E. E., Oregon State College, Corvallis, June 29–July 1, 1932.

Spanish explorers were active in California after 1542. John C. Fremont helped start a rebellion against Mexican authority there in 1846, when he was ostensibly on an exploring expedition, with the result that California was declared a territory of the United States in that year. Gold was discovered in 1848—a discovery which precipitated the rush of 1849. Nevada was visited by the fur-trader Peter Ogdon in 1825 and by another fur-trader, Jedediah Smith, in 1826. The Comstock lode was discovered in 1859. Spanish explorers visited New Mexico as early as 1536. Col. Stephen W. Kearney passed through the state in 1846.

*Early Influences.*—Mining, railroad building, the construction of irrigation projects and the development of water power brought engineering before the popular mind in a spectacular manner. The country was in the making; sons of pioneer fathers were quick to grasp the opportunity to better their condition, and, besides, follow an occupation which appealed to the restless, adventure-seeking temperament of the time. Sons of ranchers, contractors, mechanics, and miners were not seeking a college education so that they might follow in the pursuits of their fathers. Opportunities to work into the non-professional zone of the engineering profession were plentiful. The youth with ability and ambition had no trouble in learning while he was self-supporting. These boys and their parents felt, and in a measure feel to this day, that the sky is the limit to the opportunity afforded for social and economic advancement by a college education, particularly a technical education. And so, a professional training was the type universally demanded.

A very large proportion of the students in engineering, in early years, came from homes of very modest means and from parents who had had but meagre educational opportunities. The same situation was probably true with respect to all other divisions of the western universities and colleges because well-to-do parents, in the majority of cases, sent their sons and daughters east for an education.

All engineering courses began with very small enrollments and, excepting one institution, with only one or two instructors. Laboratory space and equipment were almost non-existent. As numbers increased, presidents were afforded convincing arguments for increased appropriations. There is some evidence at hand to show that certain college executives, although steeped in the tradition of classical education, grasped at the opportunity to create engineering departments even though engineering courses had been previously instituted at nearby state educational institutions.

*Influence of Mining.*—Dean Probert of the College of Mines, University of California, writes: " It may be worth noting that the

state university, probably the largest and most diversified institution of learning in the world, had its beginning in recognition of the mining industry, for at the first session of the state legislature, even before the constitution of California was written and became law, notice of the intention to establish and endow a state university to be known as the Collegio de Minera, was served upon the assembly at San Jose, and its charter assigns to the regents the especial care and protection of the College of Mining, of Agriculture, and the Mechanic Arts."

It has been stated that " the Colorado School of Mines owes its inception to the practical miners of Gilpin County, Colorado, who set aside for that purpose a portion of the receipts derived from the recording and sale of mineral claims." As the School of Mines was the first institution in this state to offer engineering courses, it has undoubtedly made an imprint on the technical education policies of the other schools in the general area.

In Nevada and Arizona, the influence of mining on the establishment of engineering courses is clear and unmistakable. At the University of Utah, also, this influence was potent in the early years. Throughout the period 1865–1900 mining was a dominant industry, if not the dominant one, in practically all of the Western states and hence in a strategical position to foster the establishment of technical education.

State bureaus of mines, generally connected with schools of mines, have sprung up in Utah, Idaho, Arizona, Nevada, Montana, and New Mexico in the years 1909 to date. These bureaus usually operate directly under the state governments and are connected to the schools by virtue of some faculty member being appointed executive secretary of the board of control, or in some cases, director. Such organizations, together with stations of the U. S. Bureau of Mines which in a number of cases are located at the schools, have given considerable impetus to graduate work in all branches of engineering and have kept the mining schools in close contact with the industry.

*Genesis.*—The Colorado School of Mines and the University of California may both rightly claim the honor of initiating engineering instruction in the West. As early as 1871 assaying and chemical tests were taught at the institution which afterwards became the Colorado School of Mines. A year prior to this date the territorial legislature of Colorado made an appropriation for a building at the school, although, at that time, the institution was not connected with the state of Colorado. At the University of California, organized in 1868, formal engineering instruction dates from 1872, although as early as 1869 a professor of physics and industrial mechanics had

been appointed. The two institutions were formed in the same year. Just which one first began engineering instruction remains to be determined. This much is certain, the University of California was the first to place engineering instruction on a sound basis.

Between the years 1880 and 1885 two institutions looked with favor on engineering—mining came into being at Nevada and a course in civil engineering budded at the Colorado Agricultural College.

Coincident with the establishment of land-grant universities and colleges during the period 1890–93 came the inauguration of technical curricula which eventually clung together and became engineering colleges within these seats of higher learning. Such institutions were the universities of Arizona, Idaho, and Wyoming and the agricultural colleges of Oregon, Utah, and Washington. Although formed at earlier dates, Colorado University and Utah University sprouted engineering departments during these years. Stanford University was opened in 1891, shortly after the founding of the New Mexico School of Mines.

After the year 1895 engineering appeared at the University of New Mexico, Montana State College, and the University of Washington. In 1900 the Montana State School of Mines was formed.

*Eastern Influence.*—In "A Comparative Study of Engineering in the United States and in Europe," Dr. W. E. Wickenden says: "Fifty years ago, C. O. Thompson, the first president of Rose Polytechnic Institute, observed from his studies of the engineering schools of Europe that there had been little change in the essential features after the first ten years of their existence. From that period on their growth was essentially a maturing rather than a formative process." Just as the engineering schools along the eastern seaboard reflected the influence of the French technical schools, so those in the western portion of the United States patterned themselves after the older institutions of the Atlantic seaboard. One would naturally expect that in the early years the professors to fill the newly-created chairs would be selected from the graduates of the older eastern schools. Were it not for Cornell alumni the above statement would hardly be true, and besides, Cornell is of the same age as the University of California and the Colorado School of Mines.

At the University of California, in its first years, engineering curricula were administered by a graduate of West Point, one from a German technical school, a Yale man, and a South Carolinian. With the exception of a Princeton graduate, who for six years headed electrical engineering, all departments of engineering at

Stanford University, including geology and mines, were inaugurated by Cornell men.

The president of the Colorado School of Mines, who assumed office in 1883, was a chemist, a graduate of Washington University at St. Louis, with post-graduate work at Lawrence Scientific School. He controlled the destinies of this institution throughout its transformation from a vocational institution to a technical college. A combination Purdue and Iowa State College graduate started civil engineering at Colorado State Agricultural College; Michigan Agricultural College, Michigan, Purdue, and Cornell continued the work. At the University of Colorado, graduates of Michigan, Illinois, Nebraska, and Pennsylvania State College have been in responsible positions since the beginning of engineering instruction there.

Oregon State College had its early development under men from Cornell and the University of Arkansas. Chicago, Illinois, Colorado School of Mines assisted in the formation of the courses at Washington State College.

In the College of Engineering of the University of Utah, graduates from that institution who received further training at Cornell and Michigan have served many years on that faculty. Columbia, Wisconsin, and McGill were represented at Montana State College, while at Utah State Agricultural College the same McGill graduate was responsible for the formation of the initial civil engineering course. The earlier faculty members of the Montana State School of Mines came from the University of Iowa, University of Minnesota, Case School of Applied Science, and Missouri School of Mines.

At the University of Washington, Lafayette College, Cornell, and Minnesota men are represented among the instructors who have remained longest at the school and have exerted the greatest influence. At the University of Nevada, a graduate from Frieberg School of Mines, Saxony, and another from the University of California started the mining curriculum. Union College, Stanford, Nebraska and Yale, University of Iowa, and Colorado School of Mines influenced engineering at Idaho. At Arizona, Pennsylvania State and Cornell, Chicago, M. I. T., and the Colorado School of Mines men have filled important positions, especially in mining.

*A Curriculum of 1894–95.*—For the third year of its existence the course of civil engineering at the University of Idaho comprised the following subjects in the freshman year: French, algebra, zoology, mechanical drawing, trigonometry, botany, surveying, and military tactics.

The sophomore year continued French, military tactics, and surveying, and introduced German, analytical geometry, inorganic

chemistry, organic chemistry, differential and integral calculus, and physiology.

In the junior year German was completed and the following subjects added: analytical mechanics, physics, roads and railroads, rhetoric and literature, mechanics, strength of materials, railroad surveying, graphic statics, and topographic drawing.

The senior year brought the student in contact with geology, stereotomy, roofs and bridges, astronomy, hydraulics and irrigation, bridge design, contract law, general engineering construction, sanitary engineering, geodesy, assaying, and a thesis.

The most serious drawback to this curriculum was the fact the professor of civil engineering taught all engineering subjects plus a large proportion of the mathematics, although in the latter department he had as an assistant the military commandant, a young officer just from West Point. Botany, zoology, and physiology were included, no doubt, because professors of botany and zoology were available for duty.

*Some Salary Figures.*—In 1883 a president of a technical school began his term of service at a salary of $3,000 per annum. A professor of engineering received $1,800 for the same period while a professor of geology was paid $1,500. The mathematics professor was evidently not classed so highly for his compensation was fixed at $1,200.

At a western university, a land-grant college, the president's salary in 1892 was $4,000. The professors of civil engineering and chemistry received $1,800 per annum. In 1908 these latter salaries were reduced to $1,500, and the recipients placed on a ten-months basis.

## Historical Sketches

*University of Arizona.*—The University of Arizona was opened to students in 1891; also, at that time, the schools of Agriculture and of Mines, and the Agricultural Experiment Station were formed. Thirty-one students were enrolled the first year, only nine of whom were of college grade. This situation is explained by Dean G. M. Butler who states that no high schools existed in the state at that date. The preparatory department of the University was abolished in 1915 at the time of the founding of the colleges of letters, arts and sciences, agriculture, and mines and engineering.

The first president of the University, Dr. Theodore B. Comstock, also filled the chair of mining and metallurgy and the directorship of the School of Mines. It is interesting to note that Dr. Comstock received the degree bachelor of agriculture, in 1868, from Pennsylvania State College. The first group of professors in engineering stayed only one or two years, and consequently did not exert a

lasting effect upon the development of engineering at the institution. Professor C. F. Tolman, Chicago, '96, was professor of geology and mining engineering from 1905 to 1912. Dr. Charles H. Clapp, M. I. T., became professor of geology in 1913. The College of Mines and Engineering, was organized in 1915 with G. M. Butler, Colorado School of Mines, '02, as dean, contained the departments of civil engineering, electrical engineering, mechanical engineering, and mining engineering and geology. At that time there were nine professors and instructors. Paul Cloke, Lehigh, '05, served as professor of electrical engineering from 1918 to 1926.

During the first ten years of the life of the University, five students received engineering degrees. A total of 317 degrees in engineering have been granted by the institution and are distributed as follows: civil engineering, 76; electrical engineering, 83; mechanical engineering, 55; mining engineering, 103.

During recent years much emphasis has been placed on graduate work, with the departments of mining engineering and geology leading.

*University of California.*—Instruction in engineering at this institution may be said to date from 1872, although as early as 1869 John LeConte, M.D., of the University of South Carolina, had been appointed professor of physics and industrial mechanics. At the same time he was acting president of the institution. R. A. Fisher, M.A., formerly of Yale University, filled the chair of chemistry, mining and metallurgy. Professor Frank Soulé, a U. S. Military Academy man, who had been appointed assistant professor of mathematics in 1869, became professor of civil engineering and astronomy in 1872. From that date until his retirement in 1907 Professor Soulé served as head of the College of Civil Engineering. When Professor John LeConte assumed the presidency in 1875, Frederick Godfrey Hesse was appointed professor of industrial mechanics and head of the College of Mechanics, a position which he filled for thirty years. Hesse, a native of Rhenish Prussia and a graduate from a technical school of that country, entered the Prussian Army where he was assigned to engineering work. He came to America in 1848. Professor W. B. Rising, the first head of the College of Chemistry, was appointed professor of mining and metallurgy in 1872. In 1879 Samuel Christy, a graduate of California, became instructor in mining and metallurgy; the year 1885 marked his promotion to the rank of professor, and later he was made dean. For thirty-five years he was connected with the College of Mines of this institution.

From 1874 until 1892 the colleges of Civil Engineering and Mechanics had each only one curriculum. Four semesters of

French or German were required in civil engineering. The mechanics curriculum called for six semesters of one or the other of these languages with German recommended. In civil engineering French was given the preference. The first two years of the curricula of the colleges were identical during the period of 1874–96.

The year 1893 marked several changes in curricula. French and German requirements were dropped in each college. Three options, railroad engineering, sanitary engineering, and astronomy and geodesy, were introduced into civil engineering. Astronomy and geodesy dropped out in 1901, to be replaced by the irrigation engineering option. From that date until the present three options have been maintained. In the College of Mechanics, in 1893, an electrical engineering option was introduced into the fourth year. A gas engineering option was offered in 1915 and withdrawn in 1919; in the latter year marine engineering appears and has continued to the present. In 1926 agricultural engineering was added, the fourth option in the college of mechanics.

In 1907 five-year curricula were offered in addition to the regular four-year curricula. The five-year arrangement contained no more engineering content than the four-year; it merely allowed more electives. All five-year curricula were abolished in 1917.

The total number of bachelor degrees granted in engineering for the period 1872–1932 is 3798, and the distribution is as follows: civil engineering, 1030; mechanical engineering (including electrical engineering), 1725; mining engineering, 905.

In January, 1931, on the retirement of Dean C. L. Cory, the Colleges of Mechanics and Civil Engineering were united to form the College of Engineering. Charles Derleth Jr., Columbia, '96, who came to the University in 1903 and who had been dean of the College of Civil Engineering, was appointed dean of the new organization. Dean Cory, B.M.E. from Purdue and M.E. from Cornell, had been appointed professor of electrical engineering in 1892 and became dean of the College of Mechanics in 1901.

From the original course in mining four options have developed —mining, metallurgy, economic geology, and petroleum engineering. The dedication of the Hearst Memorial Mining Building, a gift of Mrs. Phoebe Apperson Hearst made in memory of her husband, was a notable event in the history of this college. Constructed at a cost of $675,000, it was opened in 1907.

*Stanford University.*—When Stanford University began the enrollment of students in the fall of 1891 Charles David Marx, Cornell, '78, and Karlsruhe, '81, was head of the Department of Civil Engineering. He brought to Stanford University Professors C. B.

Wing and J. C. L. Fish, who had been his students at Cornell, and L. M. Hoskins, Wisconsin, '84. Until 1905 these four men constituted the civil engineering faculty. At the beginning 60 students were registered in the course, of whom 39 were undergraduates and 21 specials.

H. B. Gale, who resigned after the first year, was in charge of mechanical engineering. Alfred W. Smith, Cornell '78, took charge of the department in 1892 and remained until 1905. Guido H. Marx, Cornell '93, came in 1895. William F. Durand, Annapolis, '80, joined the faculty in 1904 and became executive head of mechanical engineering. The initial registration was 76 students, 42 under-graduates and 34 specials.

Frederick A. C. Perrine of the College of New Jersey and Princeton was professor of electrical engineering and executive head of the department from 1893 to 1899. From the time Perrine resigned until 1904 the department functioned nominally under C. D. Marx, or A. W. Smith. In 1905 Professor Harris J. Ryan, Cornell, '87, became the executive head..

At the opening of the University John C. Branner, Cornell, '82, was placed in charge of the Department of Geology. He afterwards served as president from 1913 to 1915. Mining engineering cannot properly be said to have started until 1908, when for a number of years this course functioned under the department of geology. In 1908 the combined departments of geology and mining had a total of 127 students.

From the beginning the degree granted for work in the engineering departments at Stanford was an A.B. with the branch of engineering designated. In civil engineering, in 1911, one year of graduate work was established, leading to the degree " Engineer." The mechanical engineering department, in 1901, had one year of graduate work leading to the degree Mechanical Engineer. Graduate courses were discontinued at the end of this year and were not resumed until 1910, when they were brought back on the same basis. In electrical engineering, from the beginning, one year of graduate work was outlined, which lead to the degree M.A. in electrical engineering. The curriculum was discontinued in 1903. In 1912 the department was placed on a graduate basis; but in 1920, when the lower division of Stanford University was organized, the A.B. in electrical engineering was resumed.

In 1925 a school of engineering comprising the Departments of Civil, Mechanical, Electrical, and Mining Engineering, and the Department of Military Science and Tactics was created by the Board of Trustees. At that time it was decided that there should be one curriculum for all undergraduates in engineering and a

curriculum was also devised which extends over a period of two years and leads to the degree "Engineer" in civil, mechanical, electrical, and mining engineering. Theodore Hoover, Stanford, '01, who had joined the faculty in 1919, was made dean of the new organization.

A total of 1717 A.B. degrees in engineering have been granted; also, 307 "Engineer" degrees.

*California Institute of Technology.*—Professor R. W. Sorensen, Professor of Electrical Engineering at the California Institute of Technology, writes: "The Institute started as Throop Polytechnic Institute, largely a manual training high school, in 1891, but some time previous to 1908 introduced two years of engineering work. In fact, I find that there were A.B. graduates as early as 1896, many of whom had work of a technical nature, probably comparable with that given by Pratt Institute in its two-year course. In 1908 a Board of Trustees decided to establish a high grade technical and research institute and policies were laid down under which we are now operating." Prior to 1910 mechanical, electrical, and civil engineering, had already been offered as real engineering courses.

In the beginning, mechanical engineering was added by C. H. Kicklighter, Georgia Tech., '02, and civil engineering by H. B. Perkins, M. I. T., '74, Franklin Thomas, Iowa, '08, became professor of civil engineering in 1913. From 1913 to 1918 W. H. Holbrook, M. I. T., '03, filled the chair of mechanical engineering, and was followed in 1919 by R. L. Daugherty, Stanford, '09. Royal W. Sorensen, University of Colorado, '05, professor of electrical engineering came to the Institute in 1910. Robert E. Ford, Minnesota, '05, who came to the Institute in 1900, was professor of applied mechanics and hydraulics from 1907 to 1919. R. A. Millikan, Oberlin College and Columbia, joined the faculty in 1921 following A. A. Noyes, M. I. T., who came in 1920.

At the conclusion of the year 1931 the bachelor of science degrees granted by this institute totalled 990, however, in the total there is included a large number of bachelor of science degrees without qualifying designation. 135 masters' degrees and 124 doctor of philosophy degrees have been granted in the same period. The total enrollment in 1931 was 550 undergraduates and 138 graduate students.

*University of Southern California.*—Engineering instruction at the University of Southern California dates from the academic year 1905–06 when courses in electrical engineering were given by the Department of Physics. A department of civil engineering was created in 1906–07. Professor Nye, Case School of Applied Science, '04, was in charge of the Department of Physics and Pro-

fessor Lawrence had the Department of Civil Engineering. Professor John F. Wilson took charge of electrical engineering in 1917 and in 1919 organized a department of mechanical engineering which was discontinued in 1924 only to be reintroduced in 1927 as a separate department under the direction of T. T. Eyre, Purdue, '05. W. W. Scott introduced chemical engineering as a separate course in 1923. In 1925 a four-year course was established leading to the degree bachelor of science in petroleum engineering.

The Board of Trustees of the University authorized the formation of a college of engineering in 1927 and appointed Phillip S. Biegler, Wisconsin, '03, who had been with the University since 1923, to the deanship.

Data on engineering enrollments prior to the organization of the College of Engineering have not been secured. In 1927 the registration was 226. In 1931–32 the total was 302.

*Colorado School of Mines.*—In 1868 when Bishop Randall established his Episcopal University near Golden, Colorado, he made provision for a school of mines in that institution. The Colorado territorial legislature was impressed with Bishop Randall's efforts, and in 1870 made an appropriation for a building at the school. Instruction in assaying and chemical tests were begun when the building was completed in 1871. The territorial assembly established the Colorado School of Mines in 1874, and at that time Bishop Randall transferred the department of mines of his institution to the territorial authorities.

Milton Moss, a practical chemist was made professor-in-charge, as the office of the president was then known, in 1878. In addition to his teaching duties Professor Moss made surveys during the summer time. The year 1881 found the faculty composed of four professors, including the president. A laboratory assistant and a janitor completed the staff. The first degree granted by the institution was awarded in 1882. In the year 1883 two degrees were granted and two again in 1886.

Dr. Victor Alderson, a former president of the institution, wrote: "The year 1883 marked the close of the formation period of the school and the beginning of the school as a high-grade technical college and conferring the full engineering degree on its graduates." That year also marked the beginning of Regis Chauvenet's term of service as president. Graduated at Washington University, St. Louis, with the degree A.B. in 1862 and A.M. in 1864, he had attended Lawrence Scientific School, Harvard University, from which he received the degree of B.S. in 1867. Of Dr. Chauvenet, professor of chemistry and metallurgy, and president of the school, it has been said: "His conception of the part that the Colorado

School of Mines could play in the development of the state, and his success in realizing his vision places him to the fore in the institution's history as the man who, more than anyone else, was responsible for the Colorado School of Mines, which became a vital factor in the state of Colorado."

Surveys made by members of the faculty in the late 80's were a great aid to Colorado in after years. In a report to the governor from the Board of Regents this matter was touched upon as follows: "During the years just closing a great deal of attention has been given by the faculty of the school, under the direction of the Board of Trustees, to expert examinations and analyses of the mineral products and natural resources of the state, such as building stones, mineral waters, oil, etc." And again, in the same report, it is stated that three members of the faculty were in the field during the summer and "the results of their efforts . . . served to show that the school, now free in part from the expense of providing buildings and apparatus for students, has commenced what promises to be the most valuable portion of its legitimate work: the examinations of the untested mineral resources and comparatively new mineral districts of the state, thus adding each year to a stock of information that should prove useful to the citizens of the state and to capitalists in other portions of the country."

During the years of its existence, including the class of 1930, 1657 students have graduated from the Colorado School of Mines.

*University of Colorado.*—The College of Engineering was organized in 1893 under the name of the Colorado School of Science. In 1895 the name was changed to the Colorado School of Applied Science, and in 1906 it became College of Engineering, University of Colorado.

In the eighth biennial report of the President of the University of Colorado, dated October 1, 1892, the following statement is to be found: "It is apparent that the growing needs of Colorado and the future of the University demand a department which already exists in most state universities. I refer to a Scientific (technological) school. The admirable work already done in the scientific and mathematical departments is a foundation for such courses as are offered, for example, in the Sheffield Scientific School. By the addition of one special professor, work in civil and electrical engineering can be begun at once. In due time we shall aim at mechanical engineering as well as at civil and electrical. The courses will be four years in length, and the college standard of admission will be required. There is no purpose to cover the ground of mining and agriculture since these departments already exist as separate schools in the state. We believe that this school will become an important department of the University."

Major Henry Fulton was elected professor of civil engineering in 1893; in 1895 he became dean. Professor Fulton received his baccalaureate degree in science at the University of Colorado when past the age of forty, and then did graduate work in civil engineering at the University of Michigan. "Brought up a New York Yankee Puritan and educated for the college of school men, he actually matriculated—in defense of the constitution—in Sheridan's cavalry, received his accolade in the wound of the battlefield and in suffering at Libby prison." George H. Rowe, Michigan, '91, was appointed to the chair of physics and electrical engineering. In a letter to Dean Evans, Professor Rowe said: "On arriving at the University of Colorado in the fall of 1893 the only thing tangible that pertained to Engineering was a one-storied brick structure of most doleful appearance." One student was enrolled in civil engineering. Rowe became dean in 1901 and served until 1903. Henry B. Dates, M. I. T., '94, took the deanship in 1903 and resigned July 1905. Milo S. Ketchum, Illinois, '95, who came as professor of civil engineering in 1904, was appointed dean in 1905 and served in this capacity until 1919. Herbert S. Evans, Nebraska, '98, who joined the faculty in 1905, was appointed to succeed Ketchum and has served until this date. John A. Hunter, Penn State, became professor of mechanical engineering in 1904.

When the school was first organized courses were offered leading to the degrees B.S. (C.E.) and B.S. (E.E.). Courses leading to other degrees were added as follows: B.S. (M.E.) in 1902–03; B.S. (Ch.E.) in 1904–05; B.S. (A.E.) in 1926–27. The Engineering Drawing Department came into being in 1906; the Department of English in Engineering in 1917. Optional courses in aeronautics were added in 1921 for seniors in mechanical engineering.

Including the class of 1931, the college of engineering has granted 1456 bachelor degrees; twenty of these in architectural engineering, 412 in civil engineering, 635 in electrical engineering, 331 in mechanical engineering, and 172 in chemical engineering. In addition, 135 masters' and professional degrees had been granted at that time. The total enrollment for 1931–32 was 718.

The college of engineering of the University of Colorado has seen its real growth and formulation of educational policies under the guidance of Milo S. Ketchum, Herbert S. Evans, and John A. Hunter.

*Colorado State Agricultural College.*—Engineering education at Colorado Agricultural College began in the summer of 1882. At that time Professor F. W. Williams, a graduate from the Stevens Institute of Technology, started the teaching of mechanical drawing and shop work in wood, iron, and blacksmithing. In this same

year Elwood Mead, an alumnus of Purdue University and Iowa State College, accepted the professorship of mathematics and engineering. In 1886 the chair of physics and irrigation was created with Professor Mead as the occupant. The name of the course was changed in 1891 to civil and irrigation engineering, a title which it retains to this date, and the degree granted is B.S. (C. and I.E.). September of 1886 witnessed the enrollment of two students in physics, two in hydraulic engineering, and one in canal work. In Professor Mead's annual report to the state Board of Agriculture, dated January 1, 1887, he says: "In establishing the chair of irrigation, the college has taken the initiative in what must soon be an important branch of industrial training in all technical schools in the arid region. In Europe every country where irrigation is practiced has a school supported and controlled by the state for the education of the irrigation engineers, in the majority of cases, admitting only the graduates of these schools into public service. In the United States, while this college is the first to offer college training in the subject of irrigation engineering, two other industrial schools have since made it a prominent feature in their course of study." Dr. Mead resigned in 1888 and was succeeded by Professor L. G. Carpenter, a graduate of Michigan Agricultural College.

Six regular seniors, six juniors, and one post-graduate were enrolled in the irrigation engineering course in 1891. Professor L. G. Carpenter resigned in 1911 and E. B. House, who had received his training at the Universities of Pittsburgh and Michigan, was made head of the department of civil and irrigation engineering. Professor House had been connected with the College since 1896, when he entered its service as an instructor in mathematics; later he became professor of mathematics and associate professor of irrigation engineering. L. D. Crain, of Purdue and Cornell, joined the faculty in 1892. He has served both as professor of electrical engineering and as professor of mechanical engineering.

In 1912 the course in highway engineering was introduced. A laboratory for testing road materials was installed in 1918 and designated as the testing laboratory for the state highway commission.

The total number of graduates in engineering from Colorado Agricultural College, including the class of 1931, is 608, distributed as follows: civil and irrigation, 301; electrical engineering, 134; and mechanical engineering, 173.

*University of Idaho.*—The University of Idaho was created by an act of the territorial legislature in January, 1889. Doors were opened to students in October, 1892. Between the years 1892–

1900 civil engineering and mining engineering were departments in the College of Arts, and the degrees B.C.E. and B.E.M., respectively, were granted. In 1900 the University was reorganized into the College of Letters and Science, the College of Agriculture, and the School of Applied Science, the latter of which comprised civil engineering, mining engineering, and electrical and mechanical engineering. Only two students were enrolled in the last named department until 1904. The School of Applied Science became the College of Engineering in 1907, and in that year electrical and mechanical engineering were separated and the Department of Chemical Engineering created. Mining engineering, metallurgy, and geology engineering were placed in a newly created School of Mines in 1917. The Department of Agricultural Engineering, under the joint administration of the College of Agriculture and the College of Engineering, was created in 1928.

John E. Ostrander, Union College, '86, was the initial professor of civil engineering and mechanic arts and was appointed in 1892. The first professor of mining engineering, Edward Goodwin, came to the University in 1896. Alfred S. Miller, Stanford, 1895, became professor of mining and metallurgy in 1898. Charles N. Little, Nebraska, 1879, Yale 1885, came to the University as professor of civil engineering in 1901 and became dean of the College of Engineering in 1911. C. L. von Ende, Iowa and Goettingen, was appointed professor of chemistry in 1908. Francis A. Thomson, Colorado School of Mines, '02, was made professor of mining and metallurgy and dean of the School of Mines, in 1917.

Since the founding of the institution some 440 bachelors degrees have been granted. Of these 140 have been in mining, metallurgy, geology, and 300 in civil, electrical, mechanical and chemical engineering. The first graduating class from the University, the class of 1896, was composed of four students, two men and two women. Both men received the degree B.C.E.

The Idaho Bureau of Mines and Geology was established in 1919. The act creating this organization names the dean of the school of mines as its executive secretary and locates the office of the Bureau at the University.

In 1914 the Idaho legislature established a "school which shall be called the Idaho Technical Institute. The purpose of which shall be the giving of instruction in such technical, vocational fields as will meet the educational needs of the students enrolled." The first two years of the engineering courses at the University were offered by the Institute, and, in addition, vocational courses were set up which in 1923 enrolled 150 students in the day and night sections. The vocational work has steadily declined until auto

mechanics is the only course of this type now offered. The state legislature of 1927 made the Idaho Technical Institute a junior college and named it the Southern Branch of the University of Idaho. At the present time, in its engineering division, of which Professor A. C. Gough, University of Kentucky, '06, is the director, the first two years' work of all engineering courses listed in the catalogue of the University of Idaho is given.

*Montana State College.*—The Montana legislature passed an act in 1893 creating the Montana College of Agriculture and Mechanic Arts, a designation which was subsequently changed to Montana State College. A. M. Ryan, the first president of the institution, was a graduate in mining engineering from Columbia University. The first curriculum tabulated was entitled "A Course in Applied Science." The second year after the founding, civil engineering is listed; in the third year mining engineering and mechanical engineering appear, but the catalogue does not name specific courses in these subjects. The president and R. E. Chandler, professor of mechanical engineering and mathematics, were the only engineering teachers during the first three years. Five students registered for the course in 1893–94, four in 1894–95, and five in 1895–96.

The first curriculum in mechanical engineering was organized by W. H. Williams who came to Montana State College from the University of Wisconsin. During the year 1896–97 Professor Williams was the sole engineer on the faculty. In 1897 an electrical engineering curriculum was organized by Williams; civil engineering came as a distinct department in 1900–01; chemical engineering appears in 1915–16; architectural engineering in 1915–16; industrial engineering in 1924–25; and engineering physics in 1924–25. Samuel Fortier, a graduate of McGill University, organized the civil engineering curriculum. Later he became director of the Montana agricultural experiment station. It will be noted that Fortier also organized the first course in civil engineering at Utah Agricultural College. The chemical engineering curriculum was organized by W. M. Cobleigh, College of Montana, '94, who has been connected with the institution since 1894, a period of some 38 years. Cobleigh became dean in 1929. During the period 1893–1914, the division of engineering was administered under the direction of a chairman. In the last named year, A. W. Ricter, Wisconsin and Cornell, was appointed dean and professor of mechanical engineering. The Engineering Experiment Station was organized in April, 1924, with Dean Earle B. Norris, Penn State, '04, as director.

The total number of degrees granted, including the class of

1931, is 586 and they are divided as follows: architecture, 24; chemical, 62; civil engineering, 133; electrical engineering 266; engineering physics, 3; mechanical engineering, 84; industrial engineering, 84.

Commencing with the year 1931–32 a two-stage plan of curricular organization went into effect. Students are not permitted to pass from the lower division, which contains the freshman and sophomore years, into the upper division until all the prerequisites for all courses of the junior year are completed with a satisfactory grade of work.

*Montana State School of Mines.*—Montana State School of Mines opened in September, 1900. Two four-year curricula were offered, one leading to the degree of mining engineer and the other to that of electrical engineer. A preparatory course offered at this time was soon discontinued. The course of study for the first two years was common to both curricula.

The first president of the institution, also professor of mathematics, was Nathan R. Leonard, a graduate of the University of Iowa. Charles H. Bowman, professor of mechanics and mining engineering came from the University of Iowa. A. N. Winchell, professor of geology, mineralogy and mining, hailed from the University of Minnesota. William J. King, professor of chemistry, received his training at the Case School of Applied Science.

In 1903 the curriculum in electrical engineering was discontinued and from that year until 1918 but one curriculum was offered, that leading to the degree of mining engineer. Metallurgical engineering, installed in 1918, was placed under the direction of Dr. H. T. Mann of the Missouri School of Mines. In 1922 the degrees of mining engineer and metallurgical engineer were changed to bachelor of science in these two subjects and a curriculum was established leading to the degree of bachelor of science in geological engineering. "All three curricula were identical until the middle of the junior year, after which time the differentiation with respect to degrees was made, although a great many courses still remain common to all three curricula." Graduate work leading to the master's degree in the three fields of mining, metallurgy, and geology was established in 1929. In 1932 provision was made for conferring the degrees of engineer of mines, metallurgical engineer, and geological engineer on the basis of achievement in these fields. Dr. F. A. Thomson, who came to the presidency of this institution in 1929 writes: "A recent innovation which has attracted interest is the requirement of English 62, Proficiency in English, credit in which must be recorded before graduation. This course is not based upon formal class work, but upon all written work submitted by the student, especially during the senior year."

Engineering education at Montana State School of Mines is heavily indebted to one of its regents, Charles W. Goodale, a mining graduate of the Massachusetts Institute of Technology, and, in the early days, manager of the Boston and Montana Consolidated Copper and Silver Mining Company.

*University of Nevada.*—Although the University of Nevada was opened in 1874, engineering instruction did not start until 1882, when the department of metallurgy, mining, and assaying was established, under G. A. Gignoux, a mining engineer from the Frieberg School of Mines, Saxony. Thirteen students enrolled in the year 1883–84, but none the next year. Robert D. Jackson, California, '82, was appointed professor of mining and metallurgy in 1888. In 1891 he gave instruction in the following subjects: solid geometry, descriptive geometry, trigonometry, elementary mining and railroad surveying, mineralogy, assaying, metallurgy, and mining. The military commandant assisted in teaching mining and mathematics. In this year Henry Thurtell, Michigan Agricultural College, became professor of mechanical drawing, and, with the exception of a year's leave of absence which he took to become the state engineer of Nevada, he remained with the University until 1907. The catalogue published in 1895 outlines a course in mechanics and one in civil engineering. George J. Young, California, 1899, was selected to become the head of the school of mines in 1900.

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Up to and including the class of 1910, 25 students had received degrees from the New Mexico School of Mines. The total number of graduates, including the class of 1929, is 153. In the school year 1929–30, 101 students were enrolled. The degree courses given at the school at the present time are mining, metallurgical and geological engineering; also, the degree of bachelor of science without special designation is granted.

*New Mexico College of Agriculture and Mechanic Arts.*—Established in 1889, this institution offers curricula in chemical, civil, electrical, mechanical, and general engineering. In 1929 coöperative courses in engineering were inaugurated. For the school year 1930–31, 156 students were enrolled in engineering courses.

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but engineering instruction began in 1905 when the professor of physics taught a course in electrical machinery. In 1906–07 the engineering faculty consisted of two members, M. F. Angell, Wisconsin, in physics and electrical engineering and A. M. Otwell in civil engineering. Courses were offered in civil, electrical, mechanical, and mining engineering.

No figures on enrollment are available until the academic year 1914–15 when 20 students were registered. At that time the engineering faculty consisted of three members. For the year 1930–31 registration in engineering was 154; fourteen bachelors degrees were granted. A total of 89 degrees, including the class of 1931, have been given.

In 1912 a chemical engineering curriculum was added and the one in mining engineering dropped. Geological engineering was offered in 1916.

At the present time four-year courses of the College of Engineering are: chemical, civil, electrical, geological, and mechanical.

*Oregon State College.*—Engineering instruction at Oregon State College may be said to have had its real beginning in 1892, when a curriculum was offered in mechanical engineering. This was altered in 1899 so that courses in electrical engineering might be elected, and in that year the baccalaureate degree in electrical engineering was authorized. The reorganization of the Department of Mathematics and Engineering into a department of Mathematics, Civil, and Mining Engineering, during 1906, marks the beginning of civil engineering. In 1908 the School of Engineering emerged. Civil engineering was subdivided in 1912 to provide a highway option. From 1907 on the school has offered degrees in the major departments of civil, electrical, and mechanical engineering, and in industrial arts.

Grant Covell, who afterwards became the first dean of the college of engineering, came to Oregon State College in 1892, and served continuously until his death in 1928. Dean Covell was a graduate in mechanical engineering from Cornell University. Gordon Vernon Skelton, from the University of Arkansas, was appointed professor of mathematics and engineering in 1895; in 1904 he became the head of the department of civil engineering, and later professor of highway engineering. M. C. Phillips, B.M.E., Oregon State College, '96, came to the mechanical engineering faculty in 1896. Ernest Hayward, a Stanford graduate, was placed in charge of electrical engineering in 1899. In 1914, R. H. Dearborne, Cornell University, '00, took charge of the Electrical Engineering Department.

The first degree—a bachelor of science in mechanical engineer-

ing—was awarded in 1893. Slowly, and with some ups and downs, the graduating classes increased in size until 1920, when 31 baccalaureate degrees were given. Commencement of 1921 witnessed a large increase, and from 1922 on the graduating class each year has numbered well over one hundred. Since the beginning, 1807 bachelor degrees in engineering have been granted at Oregon State College, and these are distributed as follows: civil, 340; electrical, 553; mechanical, 485; industrial arts, 147; chemical, 155; mining, 130.

The subjects required in the freshman year were united into a group called General Engineering in 1927. This work is administered by instructors from each of the departments of civil, mechanical, and electrical engineering working as a committee with one member as chairman.

*Utah College of Mining and Engineering.*—Founded in 1850, the University of Utah did not become active until 1857, and then for two years it was operated as a commercial college. Instruction was begun in architecture in 1883 by Joseph Don Carlos Young, a graduate of the Rensselaer Polytechnic Institute. Metallurgical instruction started with Richard H. Turhune in 1891, and at the same time Charles P. Brooks, a graduate of Sheffield Scientific School, began the teaching of civil and mining engineering. The first graduate in mining engineering received his degree in 1893. Joseph T. Kingsbury, Wesleyan, '92, professor of chemistry and physics, became vice-president of the University and principal of the mining school in 1895. He afterwards served for some years as president of the University. In 1898 Joseph F. Merrill, Michigan, '93, succeeded to the principalship of the mining school; later he became dean of the College of Mining and Engineering and Director of the Utah Engineering Experiment Station. Richard E. Lyman, Michigan and Cornell, was made instructor in engineering and mechanical drawing in 1895; the year 1899 found him assistant professor of mining engineering and mathematics; in 1901 he was made professor of mining engineering, and in 1904 he occupied the chair of civil engineering.

R. H. Bradford began his career as an instructor at the University of Utah in 1895, the year in which he received his bachelor of science degree at that institution. In 1907 he was made professor of metallurgy. E. H. Beckstrand, Michigan, '00, and Cornell, '01, came to the University in 1901 as instructor in electrical engineering. In 1907 he became professor of mechanical engineering and was placed in charge of that department. R. B. Ketchum, Illinois, '96, the present dean and professor of civil engineering, has been connected with the University for many years.

Shop work was first introduced in 1898; also, during this year the first courses in electrical engineering were offered. In 1902, four-year courses in civil and mechanical engineering were announced. From 1893 to 1900 there were no graduates; two students finished in mining engineering in 1901. Altogether a total of 837 bachelor degrees have been granted, including the class of 1931.

The Utah Engineering Experiment station was established as a department of the School of Mines in 1909. The most noteworthy achievements in the line of research have been connected with the Utah Engineering Experiment Station in coöperation with the Bureau of Mines. A large number of bulletins have been published along the line of flotation and ore dressing.

*Utah State Agricultural College.*—The Utah State Agricultural College was opened for the admission of students in September, 1890. At the beginning the College offered a four-year course in mechanical and civil engineering, also one year of graduate work in irrigation. Unfortunately, no record has been kept of the enrollment of engineering students in the earlier years of the college. Engineering instruction was curtailed, in 1906, to the teaching of irrigation engineering and mechanical arts. In 1912 the curriculum was enlarged by the addition of a course in agricultural engineering. The state legislature, basing its action upon an elaborate survey of the educational work in the state—a survey which was carried on with the assistance of the Federal Department of Education, empowered the College to offer courses in civil engineering, agricultural engineering, and mechanical arts in 1917. The College now operates in conformity with this action of the legislature. The first course in civil engineering was outlined by Dr. Samuel Fortier, a graduate of McGill University.

In the year 1931–32, 176 students were enrolled, principally in civil engineering and mechanical arts. Including the class of 1932, 65 degrees in civil engineering and 95 in agricultural engineering have been granted.

*University of Washington.*—Engineering subjects were introduced at the University of Washington in 1894. In 1898 Almon H. Fuller was appointed to the chair of civil engineering, and in 1899 to the deanship of the newly organized college of engineering. At that time he was the only instructor on the faculty of the college. A graduate of Lafayette College in 1897, he received the degree of M.C.E. from Cornell in 1898. Dorsey A. Lyon, Stanford, '98, came to the mining and metallurgical faculty in 1898 and remained until 1901. Everett O. Eastwood, educated at the University of Virginia and M. I. T., came to the University in 1905 as professor of me-

chanical engineering. Professor Magnusson, Minnesota, '96, arrived in 1906 as professor of electrical engineering, and was dean from 1917 to 1929. C. C. More, trained at Lafayette and Cornell, has been with the institution in civil engineering for some time. Milnor Roberts, Stanford, '99, has been connected with the College of Mines as professor of mining engineering and metallurgy, and as dean, since 1901. Professors Fuller, Magnusson, Moore, and Eastwood have been influential in shaping the course of the College of Engineering. During a number of years F. K. Kirsten, Washington, '09, professor of aeronautical engineering, has carried out notable research in his field.

More originated, in 1915, courses in engineering problems for freshmen which have spread to a considerable number of institutions in the last few years. In 1928 the customary freshman English courses were removed from the freshman year to the junior year. A description of Washington's experiences with these English courses may be found in the January, 1932, Journal of Engineering Education. In 1924 the department of General Engineering was organized, comprising all of the freshman work, and placed under the direction of Professor E. R. Wilcox.

An engineering experiment station was established in 1917, largely through the efforts of Professor C. E. Magnusson. The Colleges of Forestry and Mines and the Department of Physics are included with the College of Engineering in this experiment station.

At the beginning the College of Engineering was organized in three departments: civil, electrical, and mechanical. Chemical engineering registered its first students in 1904–05. Commercial engineering began in 1926–27, and aeronautical engineering was established in 1929–30.

A total of 1398 bachelor's degrees have been granted by the College of Engineering. Of these, 305 have been in civil, 178 in chemical, 17 in commercial, 532 in electrical, 213 in mechanical, and 18 in architectural engineering, 135 have been granted in general engineering. The College of Mines has given 140 bachelor's degrees and 59 graduate degrees.

*Washington State College.*—Washington State College was founded by an act of the legislature March 28, 1890, as amended by an act approved in 1891. The amendment directed that the curriculum should include mechanical and electrical engineering, mining and metallurgy, and certain fundamental courses on which these rest. The College opened January 13, 1892, with a faculty of five members, the president holding the combined professorship of mathematics and physics. Registrations during the first term

amounted to fifty-seven, but the record does not show how many of these were enrolled in engineering. The first curriculum included a four-year course in mechanic arts with junior and senior curricula in mining, civil, mechanical, and electrical engineering. Junior and senior curricula were based on the first two years of mechanic arts. In the beginning, instruction in shop practice was stressed.

Addison R. Sanders, University of Maine, was appointed professor of mechanical engineering and physics in 1893. O. L. Waller, educated at Hillsdale College and Chicago, became professor of mathematics and civil engineering in the same year. Prior to that time he had been superintendent of schools at Colfax, Washington, and had been admitted to the bar in Michigan. Professor Waller continued with the college until retirement 1930, serving as vice-president from 1909 until the latter date. In the fall of 1896, E. Darrell, a graduate of the University of Michigan, became the professor of mechanical engineering and physics and Wm. J. Roberts, M. I. T., was appointed assistant professor of mathematics and civil engineering. In 1897 civil engineering was replaced by mathematics and civil engineering. In that year Solon Sheed, Stanford University, became professor of geology and mineralogy. H. V. Carpenter, Illinois, '97, became acting head of the department of mechanical engineering in 1901. At that time this department included physics and electrical engineering. That year marked the addition of the tenth member to the engineering faculty. W. S. Thyng became acting head of the Department of Mining Engineering in 1899. F. A. Thomson, Colorado School of Mines, '04, succeeded to this position in 1907.

The second catalogue of the institution states that graduates of high schools in Spokane, Seattle, and Tacoma will be admitted on their diplomas without examination. Examinations were required of others. This statement, and the fact that for a number of years it was necessary to maintain a preparatory school, indicates the state of secondary education in this area at the time. In this catalogue the addition of courses in civil engineering and hydraulic engineering is noted. The mechanical engineering course, in addition to science and professional subjects, included two terms each of German and French, one term of rhetoric, one of general history and one each in logic and constitutional law.

In 1907 a course in architecture was established on a four-year basis. Since 1927 a three-year course in architecture has been given and, also, a four-year curriculum in architectural engineering.

The College of Mechanic Arts and Engineering was established in 1917 with H. V. Carpenter as dean. In 1919 the technical re-

search work was organized as an engineering experiment station with Carpenter as director. The School of Mines and Geology was created in 1917. Chemical engineering was begun in 1916, and in 1929 agricultural engineering was added under the joint administration of the divisions of engineering and agriculture. Dean Carpenter states, "Special curricula in combination courses in business and engineering first appeared in 1921. Students in civil engineering were offered the option of the combination courses in business and civil engineering and received their degree in management engineering. Similarly, mechanical engineering and electrical engineering students were offered four-year curricula in commercial-mechanical and commercial-electrical engineering."

At the conclusion of the academic year 1931–32, 976 students had received bachelors degrees in engineering at the State College of Washington.

*University of Wyoming.*—The University of Wyoming offered a curriculum in mechanical engineering in 1891; mining engineering appeared in 1892; civil engineering was added in 1908; and electrical engineering in 1910. The year 1922 witnessed the consolidation of these curricula into a separate college.

Professor R. L. Rhoads, the present dean of engineering at this institution, does not have records of faculty members prior to 1906. At that time W. F. Wilkinson, Colorado Agricultural College, was professor of mechanical engineering; L. W. Trumbull, Colorado State School of Mines, was head of the Mining Engineering Department; and H. T. Nowell, College of Charleston, South Carolina, was in charge of irrigation engineering.

The first degrees in engineering were granted in 1900. From then until 1925 the classes averaged four or five men each, with a class of nine men in 1922. Up to and including the year 1932, 195 bachelor's degrees have been awarded. The class of 1932 numbered 30.

The college of engineering comprises civil, electrical, mechanical, mining, metallurgical, and petroleum engineering.

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The writer desires to thank the many persons who furnished the facts upon which these historical sketches are based. Regrettable as it is, complete information concerning engineering at the University of Wyoming, the New Mexico School of Mines, and the New Mexico College of Agriculture, could not be secured at this time.

# ENGLISH IN ENGINEERING EDUCATION *

By RAY PALMER BAKER

*Professor of English, Assistant Director,* Rensselaer Polytechnic Institute

From many points of view this conference, devoted to the teaching of English to students of engineering, is a significant event. That representatives from nearly a hundred institutions of higher learning—professors of English and administrative officers—should have considered it advisable to interrupt the activities of the summer to consider such a subject is sufficient indication of the importance which it has assumed.

It is possible, however, that the novelty of this gathering may lead us astray. The inference—natural enough under the circumstances—that the teaching of English to students of engineering is a recent development in technical education is likely to confuse the issue. It has not been a matter of ten years or even twenty years. The present situation is the result of a movement that began more than a century ago. Interest in the problem is as old as the oldest institution devoted to the study of technology. In view of this fact it seems logical to examine the character and content of the courses in English offered by schools and colleges of engineering at different periods in their development; to explore, incidentally, the training and status of those responsible for the processes of instruction; to indicate the philosophy of the pioneers who gave English a place in the earliest curricula; and, finally, to discuss the position which it has attained and the rôle which it ought to play.

It is obvious that this plan of attack necessitates as a background a conspectus of engineering education in the United States. If we are to trace successfully the teaching of English to students of engineering, we must first glance at the canvas against which it has been projected. As most of you doubtless know, the oldest school of engineering in any English-speaking country is Rensselaer Polytechnic Institute, founded in 1824. For a quarter of a century it was the only institution in America devoted "to the application of science to the common purposes of life," a phrase used by Stephen Van Rensselaer, its founder, in defining the object of his benefactions. In 1847 the Lawrence Scientific School, at Harvard, due

* An address delivered at the English session of the Society's Summer School for Engineering Teachers, Ohio State University, July 11, 1932.

largely to the influence of Rensselaer, and the Sheffield Scientific School, at Yale, also linked with the tradition established in Troy, were both established. Although in 1850 a certain amount of engineering was taught at Brown and at Union, the colleges of engineering at Michigan and Pennsylvania, also indebted to Rensselaer, were not opened until after that date. In 1860, consequently, in spite of the progress made at a number of institutions, there were only four schools or colleges of engineering in the United States. The period of expansion, due primarily to the Industrial Revolution, did not begin until after the passage of the Morrill Act in 1862. The Massachusetts Institute of Technology, the Worcester Polytechnic Institute, the colleges of engineering at Columbia and Cornell, and their counterparts in the state universities of the West were all organized during the next decades. Until 1850, therefore, the teaching of English to students of engineering can be considered almost entirely in terms of the situation existing at Rensselaer. Indeed, until after the Civil War the majority of engineers in the United States had been educated in Troy under the system which it instituted. Any study of the teaching of English to students of engineering during the pre-Civil War period must therefore be based upon the practices which it afterward made current.

From the beginning rhetoric and composition were allotted a place in the curricula. "Rhetoric," indeed, appeared among the requirements as early as 1826; and the bulletin of 1827 contains a reference to the character of the "reports" demanded of students in connection with their work. In 1831 the authorities anticipated a regulation introduced recently in several institutions by announcing in the prospectus that "Rennselaer degrees cannot be obtained without a knowledge of the general principles of Rhetoric. . . ." Two years later "Composition" was also listed, thus recognizing a *fait accompli*. In 1835 daily "exercises," similar to the daily "themes" introduced at Harvard by Professor Barrett Wendell, became an essential part of the course in English. As late as 1855 "Composition," taught with due attention to the "peculiarities of grammatical and rhetorical construction," was still required of all undergraduates, upperclassmen as well as lower classmen. Historically, therefore, rhetoric and composition occupy a privileged position in the development of engineering education.

At Rensselaer, however, the art of writing was not the only phase of English to receive consideration. Fully as much emphasis was placed upon public speaking. According to the catalogue of 1853, "English Composition and Elocution are recognized . . . as a part of the course of education at the institution. The following exercises . . . are of daily occurrence." As a matter of fact, care

in the oral expression of ideas had always been stressed by the faculty. As early as 1827 they drew attention to the advisability of including in the curricula studies that would aid in "disciplining the mind to the habit of accurate discrimination, systematic arrangement, and extemporaneous speaking." In keeping with this policy, set forth more fully in 1833, every student was required to deliver weekly five "lectures," each of which was criticized from the point of view of "style" and "manner." The importance attached to form is indicated by a statement, due obviously to the Director, that "independent of the effort constantly made, to insure accuracy of information in all subjects, so far as they are pursued, attention to the *manner* in which a student pronounces an extemporaneous lecture, is not less an object of constant solicitude." At Rensselear, therefore, public speaking, like composition and rhetoric, was accorded a well-defined niche in its educational structure. Almost as interesting is the attempt of the administration to correlate these subjects with those that are distinctly technical.

Although it is clear that the teaching of English had a professional bias, literature was by no means neglected. In 1844 one of the functions of the president was to deliver a course of lectures upon that subject, as well as upon philosophy. In due time this course, given at first independently, was combined with that in "Composition" as "Criticism,"—a union that persisted for several years. By 1854, however, the courses in English, required in all years, had been organized in three divisions: (1) Composition; (2) Elocution; and (3) Criticism. Like public speaking and rhetoric and composition, literature has also been associated with the development of engineering education.

The outlines which have survived point to a high standard of attainment in all these courses. Although it is unnecessary, for the purposes of this discussion, to explore their content, it is interesting to notice that the titles of the texts assigned for study indicate the seriousness with which they were regarded. The names of the authors—Blair, Fowler, Hallam, Kane, Trench, Roget—form a remarkable galaxy that illuminates the canon of our subject. Nor was their influence limited to the classroom because in 1847 "besides the regular exercises of the Institution, a society of the students for the special cultivation of the Arts of Elocution, Composition, and Forensic Discussion," was "in active operation." Indeed, the Literary Society, as it was eventually called, became a powerful force in the life of the Institute.

The schools and colleges of engineering were not only alert to the need of instruction in English but they were also pioneers in the field. Many of you will be surprised to hear that they clashed

with tradition in giving to the language and literature of the vernacular a recognized place in any scheme of higher education. So far was Rensselaer in advance of its academic contemporaries, still dominated by the classics, that the Board of Trustees found it difficult to secure teachers who were qualified to present these subjects. At first, therefore, the courses were conducted by members of the staff who were assigned to other duties. In due time, however, the need for some degree of specialization became apparent. Consequently, in 1854, the authorities announced that "the two chairs of Chemistry and English Composition," which were "vacant" but "provisionally supplied by temporary arrangements," only awaited "the determination and appointment by the Trustees of suitable persons as permanent incumbents." Evidently, however, in the case of "English Composition" little assistance could be expected from the older institutions of the East. Consequently, in the following year James Theodore Allen, a graduate of the Institute, a widely travelled gentleman and an experienced teacher, was appointed Professor of English. So far as I can gather, he was the first, or at any rate among the first, in the United States to hold that title. Certainly he was the first in any school or college of engineering. A little later instructors in "English Composition and Rhetoric" and in "English Language and Literature" were added to the staff. Like Allen, many of those who succeeded him were graduates of the Institute. Other graduates, it is worthy of record, became distinguished as scholars and teachers of English in other institutions. One, Joseph Thomas, the lexicographer, held various professorships in the United States. Another, Fitz-Edward Hall, of the University of London, became one of the most eminent philologists of the day. In more than one respect, therefore, the schools and colleges of engineering have been pioneers in the teaching of English.

In view of this fact we may well explore the attitude of those who laid the foundations of engineering education in America. What place did they give to the subject in the system which they instituted? To answer that question I would have to explain the ideals of Amos Eaton, the first academic head of Rensselaer Polytechnic Institute. An original thinker, far in advance of his time, he not only established field work and laboratory practice as essential elements in any scheme of higher education but he also proposed other changes in educational procedures that are to-day reflected in the curricula of every university. The present status of the schools and colleges of engineering is due, however, not to Amos Eaton but to B. Franklin Greene, who reorganized the curricula at Rensselaer in 1850 and in 1855 published his famous *Report*, the

most epoch-making document in the history of engineering education. In connection with the subject of the day his provision for a "General School," "scientific, literary, philosophic, artistic," and "Special Schools," based upon it, is particularly significant; for it makes clear that he conceived of the problem in terms of a "liberal education" as well as a professional training. English was to minister, therefore, to both of these ends.

To emphasize his point of view I cannot do better than quote a couple of passages from his Report:

> We trust that we have, at least, partially succeeded in realizing the purpose mainly contemplated in the preparation of this paper. We wish to make clearly apparent *what the Institute really is* as an educational establishment. On this point, as remarked in another place, considerable misapprehension has existed, and, we believe, still prevails in certain quarters . . . and there are others, who, while assuming that the Institute may possibly serve a valuable purpose in the diffusion of certain useful kinds of knowledge, do not understand that it professes, or is at all adapted, to present anything like a system of *general or liberal education*. . . .
>
> We affirm the truth of the following proposition,—that *the idea of the Polytechnic Institution, fully worked out, embraces an array of appliances adapted to the most complete realization of true educational culture.* We have no good reason for believing that man was intended to live the life of a monk in his cloister. To say nothing more, mediæval have changed to modern times; and, confessedly, without speculation on the much vexed question of what was, or can be, the era best suited to the display of man's varied powers, it is enough for our present purpose to know, beyond any doubt, that his truest interest not less than his highest duty consists with the most resolute adaptation of himself to the demands and circumstances of the age in which he lives—that is, the *present age.* What, then, we beg to ask, is the kind of education which best comports with the idea of such an adaptation? Should not such an education aim at the development and cultivation, so far as may be practicable, of man's whole powers of perception, of thought, of feeling, of expression. . . ?
>
> As intimated in a preceding paragraph, the idea is not infrequently entertained that, because the Institute is primarily designed for the education of Engineers and other professional Technists, its educational system must of necessity be partial and one-sided; that, because the Institute is neither in name nor in form a Classical "College," whatever be its excellence in other respects, there must, forsooth, *inhere* the radical defect of incapacity to secure to its graduates that completeness of scholarly culture, which is comprehended in the idea of a "liberal education." Is the popular interpretation, as derived from the objects, organizations, and usages of old and honored Universities, essential to the idea of such an education? If so, how shall we select the epoch in the history of these institutions, in which to find the truest expression of educational standards? Must we, in deference to those who lament the decline of classical learning visit the English University of the seventeenth century, when nearly all learning, with the exception of Theology, consisted in teachings or interpretations of Greek and Roman authors? Or, shall we, in paying due attention to the views of those who are clamorous for the *maximum amount of study in a minimum time,* come down to the present period and take our standard from some of the American Colleges?
>
> We are conscious of no ambition to run a tilt against Classical Institutions, feeling well enough assured that we should but shiver our lance in the attempt; and we have even less inclination for a task so un-

gracious to one having any real love of learning. We have too much reverence for those asylums of learning of the middle ages, which, in despite of political and religious convulsions . . . have been preserved to the present day, to join in a cry which is too often most loudly echoed by those who would sink all learning to the level of the merest empiricism. Our only object, indeed, in touching upon a theme so prolific of discussion, and withal so unsuited to the objects of this paper, is, that, while directing attention to the countless varieties of standard of University education—not only as naturally due to chronological changes in the state of learning, but as scarcely less strikingly observable in contemporaneous institutions, we may suggest the possibility of conceiving that the system of education more or less common to the Polytechnic Institutions of modern times, although materially different in kind, might, nevertheless, as a parallel system of educational culture, be little inferior—to say nothing more—to some of the former. . . .

The question may be raised as to the utility of such studies as Rhetoric, Philosophy, etc., to the Architect, Engineer and other Technists. It is a natural question, and one not unfrequently asked in these days, when the element of *time* which is spent in connection with education is estimated at so high a value. Experience has shown conclusively enough to all thoughtful observers that, in a course so largely—in its very necessities—*material*, as that which obtained in a Polytechnic Institute, there should be introduced compensating or balancing elements. And what studies so suitable as those which cause us to turn from the observation of *things* without, to the contemplation of the wonderful phenomena and resources within, the Human Mind? Apart from all consideration of the practical advantages which accrue even to the Technist—and they are not only manifold in fact, but *ought to be obviously so* to all intelligent and discriminating observers—from this class of studies, we repeat that, viewed as a mere *equipoise* to the study of the Mathematical, Physical and Technical Sciences, we believe they should find a prominent place in the educational system of every Polytechnic Institution. . . .

Such, then, was the status of English in engineering education at the end of the pre-Civil War period, ending in the Sixties. For some years there was little change in its position. When the newer technical schools, exemplified by the Massachusetts Institute of Technology and the colleges of engineering in the state universities, represented here by the University of Michigan, began to emerge, they followed in general the pattern fixed by Greene. In them also English was given due recognition. Because of the progress of science and the material development of the United States during the last quarter of the nineteenth century and the first decade of the twentieth, the tendency toward empiricism against which Greene had warned his contemporaries soon became apparent. As a result of insistence upon specialization in the schools and colleges of engineering—an emphasis common to all institutions of higher learning—the studies of the "General School," English included, were often subordinated to those which appeared to be more directly utilitarian. During this period, therefore, the time and attention devoted to the subject steadily declined.

Within the last twenty years, however, because of changes with which you are all familiar, engineering education, stimulated by the Society under whose auspices we are meeting to-day, has grad-

ually recaptured the ideals set forth by Greene, whose *Report* is as valid now as when it was published nearly eighty years ago. Consequently the study of English, an essential part of the scheme which he formulated, has again assumed significance. Everywhere it is regarded not only as a tool, comparable to mathematics, but also as a medium of culture, contributing to the "liberal education" upon which he insisted. If, therefore, we have followed a long, but I hope not altogether unpleasant trail, we have nevertheless reached at last the status of English to-day.

In conclusion, without trespassing upon the ground of those who are to follow me, it may not be inappropriate to consider briefly the rôle which it now plays in engineering education. To that rôle the history of the schools and colleges of engineering obviously points the way. If it be true that their function is twofold, liberal as well as professional, then the study of English should minister to both aims in something like equal proportion. It should, so far as possible, aid a student to think, to speak, and to write like a man of affairs and to anticipate the demands that will be made upon him in the practice of his profession. More specifically, it should provide him with the equipment of an educated gentleman and the means of adapting it to the exigencies of his career. For these reasons rhetoric and composition, if treated imaginatively with reference to topics of immediate concern, belong of right in the freshman year. For a more advanced course in writing, supplementary to it, as good a case can easily be made. In addition, however, to those phases of English which are usually regarded as inherently utilitarian, and which, too often, are treated in such a matter-of-fact manner as to destroy their usefulness, those aspects which deal more exclusively with ideas are not less important. Even from a materialistic point of view, a knowledge of the chief intellectual movements of the nineteenth and twentieth centuries, as reflected in the literatures of England and America, is essential to success. Only a student who is familiar with the tendencies which they have released, and which they interpret, is likely to understand the drift of contemporary civilization and the import of the studies through which he may learn to minister to its needs.

Culturally as well as vocationally, English, like mathematics, should be, and is now almost universally, regarded as fundamental to any scheme of engineering education. Because of the disappearance of French and German from the curricula, except as a means to an end, it has become increasingly important. The only force that can dislodge it from the position which it has attained is the failure of those who profess it to bring to the classroom the originality, the power, and the inspiration that the schools and colleges of

engineering have a right to demand. As I glance at the topics which have been proposed for discussion, at the names of those selected to discuss them, and at the institutions with which they are connected, I have little fear that the teachers of English will surrender the gains for which this Society is so largely responsible.

It is interesting to notice that the papers on the programme, arranged with such skill and understanding, cover every phase of the subject that is likely to appeal to undergraduates. That the students themselves have been uppermost in the minds of those who organized these sessions is a fact that is peculiarly significant. In view of the conventional and ineffective methods of instruction with which many of our colleagues have too often been content, it is possible that a symposium of this character, reflecting experiments in many fields, may lead, as in the past, to repercussions that are entirely unexpected. One of the justifications for the historical approach adopted in this sketch, designed as an introduction to the work of the School, is the possibility that it may accelerate the development of an *esprit de corps* among the members of this group. It is no longer necessary to apologize for such an association. The teaching of English to students of engineering has back of it distinguished tradition, wrought by many institutions, to which any scholar may be proud to belong. The more we learn of its manifestations, the fruits of many adventurers, the more likely will we be to esteem the privileges of this fellowship.

So far we have dealt largely with the past, significant as always, because it has given to the subject with which we are concerned a place from which it cannot escape. Hereafter we shall have to do with the present. Although the teaching of English in schools and colleges of engineering was established during the pre-Civil War period, emphasis and content have necessarily changed. As the programme indicates, many institutions have contributed to its progress during the last two decades. They have welcomed innovations, and they have permitted others to profit from their experiences. Those who listen to the representatives who will deal with their contributions will unquestionably leave the halls of this university, to whose hospitality we are so greatly indebted, not only with a quickened sense of comradeship but also with a fuller realization of the opportunities for useful service offered to teachers of English by the schools and colleges of engineering.

# EDUCATION AND EMINENCE IN ENGINEERING

By BURKE SMITH

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Interest in post graduate education for engineers is increasing and educational facilities for training in advanced subjects have developed rapidly in recent years. But there are some who will question whether post graduate study is really worth while in a profession such as engineering in which not even an undergraduate training is required of one who wishes to practice it. There are many distinguished engineers who have had little or no formal training of collegiate grade. The present study was undertaken to throw more light on this question and on the closely related one of how much value in the practice of engineering is attached to a record in college of high scholarship and promise of achievement in research. In other words, what rôle do post graduate training and marked intellectual capacity as an undergraduate play in the achievement of success in engineering.

A number of studies of college education in relation to success after graduation have recently been made.[1] However, they have all emphasized earnings as a measure of success. While earnings comprise perhaps the most direct method of measurement, there is a limitation to their use, especially in studies covering men in education as well as in business and the professions. It may therefore be of some interest to have the results of studies of success based on criteria other than earnings. In the present instance professional eminence has been used as the criterion.

## Sources of Information

The results here given are based on a study of 3,247 biographies of engineers taken from the third (1931) edition of Who's Who in Engineering. 434 (13.4 per cent) of these names also appear in Who's Who in America and were used as a comparison group.

[1] D. S. Bridgman, "Success in College and Business"; *Proc. S. P. E. E.,* Vol. 37, p. 915, 1929.

A. S. M. E., "1930 Earnings of Mechanical Engineers"; *Mechanical Engineering,* Sept., Nov., Dec., 1931.

D. S. Bridgman, "Earnings of Land Grant College Alumni and Former Students"; Jour. Eng. Educ., Nov., 1931.

A. H. White, "Occupations and Earnings of Chemical Engineering Graduates"; *Industrial and Engineering Chemistry,* Vol. 24, p. 204, Feb., 1932.

This edition of Who's Who in Engineering contains brief biographies of some 10,800 engineers. The basis on which the volume was compiled was laid down by an advisory committee of engineers appointed by the American Engineering Council and representing eight of the National Engineering Societies. According to a statement in Who's Who in Engineering only names which meet the following qualifications were included:

1. Engineers of outstanding and acknowledged professional eminence.
2. Engineers of at least 10 years' active practice, at least five years of which have been in responsible charge of important engineering work.
3. Teachers of engineering subjects in colleges or schools of accepted standing who have taught such subjects for at least 10 years, at least 5 years of which have been in responsible charge of a major engineering course in such college or school.

From these qualifications it is evident that no educational achievement is necessary for inclusion of one's name in this volume and many individuals are listed who have had no college training. A reading of the biographies also indicates that many persons are included (principally executives and scientists) who, while they may be engineers, have, as their main occupation, some other related activity. One would expect to find this situation since, as is well known, there is no clearly defined boundary line which separates the professional status of engineering from other closely related activities. Furthermore, as is usually the case in a compilation of this kind the names of many persons are included who have little if any claim to distinction and many other names which should be included are not. However, it is the most readily accessible list of biographies of engineers and on the whole, from the way the volume was compiled, it is fair to assume that the great majority of those included have achieved some degree of success in engineering.

For the present study, 30 per cent of the names appearing in Who's Who in Engineering were selected by tabulating all names in the first 30 pages of each 100 throughout the volume on punched cards which could be sorted mechanically. After rejection of about 1 per cent who were obviously not engineers, a total of 3,247 names remained. Of these, 202 or 6.2 per cent indicated that they had had no college training; 432 or 13.3 per cent had had some college training but from the record it was not apparent that they were college graduates. A study of the biographies of the remaining 2,613 (80.5 per cent of the total) made it possible to determine the number who had taken post graduate work but had not

received advanced degrees, those who received masters, Ph.D. and professional degrees and other information of an educational nature. As far as could be determined, only degrees in course were included in the data for this study. For this reason doctorates other than Ph.D.'s were not counted as it was impossible to determine how many were honorary.

While the 3,247 individuals chosen from Who's Who in Engineering are a select lot, it cannot be said that they have attained professional eminence as a group. Furthermore, they cannot be compared directly with the average of all practicing engineers since there are no suitable statistics available pertaining to the latter, although some of the figures for the older graduates from the S. P. E. E. report of 1923–29 may be used for this purpose. To obtain a group which could be used as a basis of comparison and which is made up of more distinguished individuals the names selected from Who's Who in Engineering were compared with the 16th (1930–31) edition of Who's Who in America and a total of 434 names were found which appeared in both of these volumes. For the purpose of this study these 434 engineers were assumed to have attained professional eminence. In adopting this procedure, it is recognized that there are no criteria which will be universally accepted as defining eminence. Moreover, Who's Who in America does not offer an entirely satisfactory list of names since it probably overemphasizes success in educational and scientific fields as compared to equal eminence in administrative and engineering positions. However, the course adopted has the advantage of making readily available a considerable amount of statistical material in regard to a group of engineers, most of whom unquestionably have attained professional eminence to a high degree.

## Comparison of Who's Who in Engineering (W. W. E.) and Who's Who in America (W. W. A.) by Educational Groups

In what follows the abbreviation W. W. E. will be used for Who's Who in Engineering and W. W. A. for Who's Who in America. Table 1 shows the distribution of names in W. W. E. and W. W. A. by educational groups, while Fig. 1 shows the per cent listed in W. W. A. It will be noted from Fig. 1 that with the exception of the group of 202 engineers who have had no college training, the per cent of names in each group appearing in W. W. A. increases with the degree of education from 8.6 per cent for the group with some college training but no degree, to 43 per cent for those having Ph.D. degrees. One would conclude that the more education the members of a given group have had the greater is the proportion of distinguished individuals in that group, as measured by inclusion of names in W. W. A.

TABLE 1

DISTRIBUTION OF NAMES IN WHO'S WHO IN ENGINEERING AND WHO'S WHO IN AMERICA BY EDUCATIONAL GROUPS

| Educational Group | In Who's Who in Engineering | | In Both Who's Who in Engineering and Who's Who in America | |
|---|---|---|---|---|
| | No. | Per Cent | No. | Per Cent |
| No college training | 202 | 6.2 | 19 | 4.4 |
| Some college training but no degree | 432 | 13.3 | 37 | 8.5 |
| College graduate but no post-graduate work | 1826 | 56.2 | 191 | 44.0 |
| Post-graduate work but no advanced degree | 255 | 7.9 | 40 | 9.2 |
| Masters degree but no Ph.D. degree | 353 | 10.9 | 70 | 16.1 |
| Ph.D. degree | 179 | 5.5 | 77 | 17.8 |
| Total names studied | 3247 | 100.0 | 434 | 100.0 |

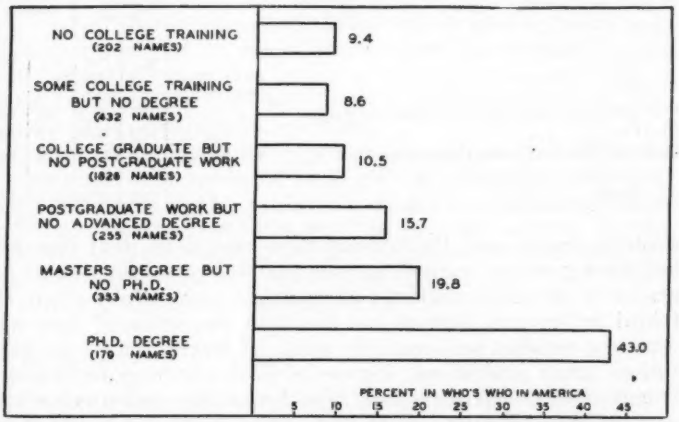

NO COLLEGE TRAINING (202 NAMES)
9.4
SOME COLLEGE TRAINING BUT NO DEGREE (432 NAMES)
8.6
COLLEGE GRADUATE BUT NO POSTGRADUATE WORK (1826 NAMES)
10.5
POSTGRADUATE WORK BUT NO ADVANCED DEGREE (255 NAMES)
15.7
MASTERS DEGREE BUT NO PH.D. (353 NAMES)
19.8
PH.D. DEGREE (179 NAMES)
43.0
PERCENT IN WHO'S WHO IN AMERICA
5 10 15 20 25 30 35 40 45

FIG. 1. Distribution by educational groups of 3,247 names in Who's Who in Engineering showing per cent in Who's Who in America.

The group of 202 engineers with no college training shows a slightly higher proportion of individuals in W. W. A. (9.4 per cent) than the group with some college training but no degree (8.6 per cent). This may be due partly to the fact that there is a greater proportion of high executives in this group than in the entire group of 2,613 college graduates (19.3 per cent as compared to 10.5 per cent). There is also a larger proportion of inventors

in this group as compared with the entire group (24.2 per cent as compared to 16.9 per cent). The principal reason for the difference, however, seems to be due to differences in age. The median age of those who have had no college training is 50½ years while that of the group of 432 engineers with some college training but no degree is 46 years. Other things being equal, the larger the proportion of older individuals the larger the percentage of names listed in W. W. A.

## Post-Graduate Work

Table 2 contains data on the post-graduate work of the entire group of 2,613 graduates in W. W. E. On the basis of the number of

TABLE 2

Post-Graduate Training

| | Who's Who in Engineering Group (2613 Names) | | Who's Who in America Group (378 Names) | |
|---|---|---|---|---|
| | No. | Per Cent | No. | Per Cent |
| Post-graduate work but no advanced degree | 255 | 9.7 | 40 | 10.6 |
| Ph.D's | 179 | 6.8 | 77 | 20.3 |
| Masters (Not including those with Ph.D's) | 353 | 13.5 | 70 | 18.5 |
| Total | 787 | 30.0 | 187 | 49.4 |

master's degrees and Ph.D.'s and those who stated that they had had some graduate work, it appears that 787 or 30 per cent of the graduates have had resident post-graduate work. Many others obtained professional degrees and a certain proportion of these also represent resident post-graduate work. However, since some institutions grant professional degrees without requiring residence, it is impossible to determine from these figures the exact number with post-graduate training. In the data which follows, it should therefore, be understood that the figures for post-graduate work are low unless those with professional degrees are included in which case they would probably be high.

The S. P. E. E. report [2] of 1923–29 indicates that 13.7 per cent of the older graduates of engineering colleges have had post-graduate work as compared to 30 per cent in the group of 2,613 graduates shown in Table 2. These figures cannot be compared directly, however, since the data in the S. P. E. E. report pertain to grad-

[2] Report of the Investigation of Engineering Education, 1923–29, Vol. 1, p. 243.

uates of engineering institutions only, while many of those listed in W. W. E. are arts and science graduates, and a large percentage of the masters' and doctors' degrees in Table 2 were awarded in physics or chemistry rather than in engineering. It is well known that the number of advanced degrees in course which have been conferred in engineering has, until recently, been small; for example, Massachusetts Institute of Technology, prior to the World War, had awarded only 73 masters' degrees and 3 doctorates in engineering.[3] Opportunity for post-graduate work was not as generally available to students from engineering schools thirty years ago as during the last decade.

Of the 22,000 graduates of Land Grant Colleges and Universities studied by Bridgman,[1] nearly 30 per cent had had some post-graduate training. However, about 12,000 were graduates who matriculated in 1919–21 and were therefore as a group much younger than the graduates here studied. White [1] found from his study of chemical engineers that only one-sixth of the pre-war graduates pursued post-graduate studies, whereas more than one-third of the group graduating in 1920–30 devoted at least a year to post-graduate study. Of the group of graduates here considered practically all are pre-war graduates and it therefore appears that, as a whole, they have had distinctly more post-graduate training than the general average of older graduates.

Table 2 also contains data on the post-graduate training of the 378 graduates who are listed in W. W. A. The total with post-graduate training is 49.4 per cent as compared to 30.0 per cent in W. W. E. The larger percentage of doctors' and masters' degrees in W. W. A. as compared to W. W. E. is especially noticeable, the number of individuals with one or both of these degrees being 38.8 per cent of the group as compared to 20.3 per cent in W. W. E.

### Scholarship and Promise of Achievement in Research

The biographies given in W. W. E. include information in regard to honor societies in which membership is based on scholarship or other intellectual attainments. Engineering students are eligible to election to many such societies but membership in some is limited to students in special branches of engineering such as Civil, Mechanical, etc. Three general honor societies were selected for this study namely, Sigma Xi, Tau Beta Pi and Phi Beta Kappa. Election to membership in Tau Beta Pi or Phi Beta Kappa is primarily on the basis of scholarship. Phi Beta Kappa is open only

[3] J. C. MacKinnon, "Graduate Engineering Instruction," *Technology Review*, February, 1932. These figures do not include 50 masters' degrees awarded to Annapolis graduates.

to students who have taken undergraduate work in Liberal Arts, but many engineers listed in W. W. E. are members, indicating that they have a background of undergraduate training in the arts and sciences. Tau Beta Pi is awarded to undergraduate students in engineering. The combined group of Tau Beta Pi and Phi Beta Kappa members represent a selected list of individuals who were in the upper one-quarter to one-eighth of their classes in scholarship.

Sigma Xi is awarded primarily on the basis of promise or actual achievement of research. It is awarded largely to post-graduates although in some institutions a small number of associate members are elected from the undergraduate classes.

Members of these societies represent a group of individuals who exhibited superior intellectual ability while in college. Table 3 indicates that 28.7 per cent of the W. W. E. group belong to one

TABLE 3

MEMBERSHIP IN HONOR SOCIETIES

| | Who's Who in Engineering Group (2613 Names) | | Who's Who in America Group (378 Names) | |
|---|---|---|---|---|
| | No. | Per Cent | No. | Per Cent |
| Membership in Sigma Xi | 432 | 16.5 | 122 | 32.2 |
| Membership in Tau Beta Pi | 398 | 15.2 | 80 | 21.1 |
| Membership in Phi Beta Kappa | 125 | 4.8 | 45 | 11.9 |
| Membership in Tau Beta Pi or Phi Beta Kappa or both | 501 | 19.2 | 111 | 29.4 |
| Membership in one or more of the three Honor Societies | 750 | 28.7 | 171 | 45.1 |

or more of these societies while 19.2 per cent belong to Tau Beta Pi or Phi Beta Kappa. It is believed that these percentages are substantially higher than the general average for graduate engineers of comparable age. The figures cannot be compared directly with those for recent graduates since in many institutions 25 years ago, especially in the smaller colleges, there were no chapters of these societies and many qualified graduates did not have an opportunity to be selected for membership.

A comparison of the W. W. A. and W. W. E. groups by membership in the three societies is also shown in Table 3. Members of these three societies constitute 45.1 per cent of the W. W. A. group as compared to 28.7 per cent of the W. W. E. group. Membership in Sigma Xi in the former group is double that in W. W. E. while

Phi Beta Kappa membership in W. W. A. is two and one-half times that in W. W. E.

### Special Groups

In view of the evident close relation between post-graduate training and inclusion of names in W. W. A. as shown in Fig. 1, the 2,613 graduates were divided into the following five sub-groups for further study. The division was made on the basis of the stated occupations.

Group 1. All teachers.
Group 2. All who were formerly teachers but are now in some other kind of work.
Group 3. All consulting engineers.
Group 4. All presidents and vice presidents.
Group 5. All names remaining after the first four groups were subtracted out.

This division gives three functional groups of engineers, namely, teachers of major engineering subjects, expert practicing engineers (consulting engineers and former teachers) and a group of high executives who probably began as engineers but are now almost entirely concerned with administrative and management problems. There is some overlapping of Group 2 with Groups 3 and 4, but Groups 1 and 5 are distinct.

A comparison of the data for these groups with that of the entire group of 2,613 graduates is shown in Table 4. On the whole, post-graduate training, high scholarship and inclusion in W. W. A. go together. Group 5, however, is an exception in that it has nearly the same degree of post-graduate training and honor society membership as the group of executives, but only one-half as large a percentage of names included in W. W. A. as the executive group. It will be shown later that this may be accounted for by differences in age.

Table 4 also shows the percentage of engineers with professional engineering degrees. There is evidently a close relation between these figures and the percentage of names listed in W. W. A. for the various groups. This is to be expected, since such a degree represents professional achievement and in many cases resident post-graduate work. It may in fact be regarded as evidence of post-graduate study.

The former teachers form an interesting group, as they rank next to the highest in percentage of eminent individuals and also

TABLE 4

COMPARISON OF EDUCATION OF SPECIAL GROUPS OF GRADUATES FROM WHO'S WHO IN ENGINEERING

| | Group 1 Teachers (449 Names) | | Group 2 Former Teachers (244 Names) | | Group 3 Consulting Engineers (351 Names) | | Group 4 Executives (274 Names) | | Group 5 All Graduates Less Groups 1 to 4 (1,356 Names) | | All Graduates (2,613 Names) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Per Cent | No. | Per Cent | No. | Per Cent | No. | Per Cent | No. | Per Cent | No. | Per Cent |
| 1. Post-graduate work | | | | | | | | | | | | |
| Post-graduate work but no advanced degree | 37 | 8.2 | 31 | 12.7 | 34 | 9.7 | 24 | 8.9 | 130 | 9.6 | 255 | 9.7 |
| Ph.D.'s | 73 | 16.3 | 45 | 18.4 | 21 | 6.0 | 4 | 1.5 | 45 | 3.3 | 179 | 6.8 |
| Masters (Not including Ph.D.'s) | 133 | 29.6 | 48 | 19.7 | 38 | 10.8 | 30 | 10.9 | 119 | 8.8 | 353 | 13.5 |
| Total | 243 | 54.1 | 124 | 50.8 | 93 | 26.4 | 58 | 21.2 | 294 | 21.7 | 787 | 30.0 |
| 2. Professional degrees | 138 | 30.7 | 52 | 21.3 | 61 | 17.4 | 46 | 16.8 | 251 | 18.5 | 537 | 20.5 |
| 3. Membership in Honor Societies | | | | | | | | | | | | |
| Membership in Sigma Xi | 164 | 36.5 | 75 | 30.7 | 42 | 12.0 | 36 | 13.1 | 137 | 10.1 | 432 | 16.5 |
| Membership in Tau Beta Pi | 132 | 29.4 | 38 | 15.6 | 52 | 14.8 | 26 | 9.5 | 164 | 12.1 | 398 | 15.2 |
| Membership in Phi Beta Kappa | 40 | 8.9 | 16 | 6.5 | 17 | 4.8 | 12 | 4.4 | 45 | 3.3 | 125 | 4.8 |
| Membership in Tau Beta Pi or Phi Beta Kappa or both | 160 | 35.6 | 53 | 21.7 | 59 | 16.8 | 32 | 11.7 | 203 | 15.0 | 501 | 19.2 |
| Total membership in one or more of the three Honor Societies. | 233 | 51.9 | 103 | 42.2 | 91 | 25.9 | 64 | 23.3 | 290 | 21.4 | 750 | 28.7 |
| 4. Included in Who's Who in America | 124 | 27.6 | 54 | 22.1 | 66 | 18.8 | 48 | 17.5 | 108 | 8.0 | 378 | 14.5 |

*Note:* This table should be read as follows: 37 or 8.2 per cent of the teachers in Who's Who in Engineering have had post-graduate work but no advanced degree, etc.

in post-graduate work and scholarship. An analysis of this group indicates the following principal types of employment:

| | |
|---|---|
| Administrative (of the grade of Manager or higher) | 13.9% |
| Research | 16.0% |
| Consulting | 20.5% |
| Miscellaneous | 49.6% |
| | 100.0% |

Table 5 shows the distribution of the five special groups in W. W. E. and W. W. A. Each of the first four groups constitutes a

TABLE 5

DISTRIBUTION OF FIVE SPECIAL GROUPS IN WHO'S WHO IN ENGINEERING AND WHO'S WHO IN AMERICA

| | Per Cent of W.W.E. Group (2613 Graduates) | Per Cent of W.W.A. Group (378 Graduates) |
|---|---|---|
| Group 1. Teachers | 17.1 | 32.8 |
| Group 2. Former teachers | 9.3 | 14.3 |
| Group 3. Consulting engineers | 13.4 | 17.5 |
| Group 4. Executives | 10.5 | 12.7 |
| Total in 4 groups | 48.0 | 71.4 |
| Group 5. Remainder | 52.0 | 28.6 |
| | 100.0 | 100.0 |

*Note:* On account of overlapping of Group 2 with Groups 3 and 4 the percentages total more than 100. Groups 1 and 5 do not overlap with other groups.

This table should be read as follows: The teachers comprise 17.1 per cent of the W.W.E. group and 32.8 per cent of the W.W.A. group, etc.

higher percentage of the total in W. W. A. than in W. W. E. In W. W. A. the four groups make up 71.4 per cent of the total. It appears that these groups constitute the most significant portion of both W. W. E. and W. W. A. for the purpose of this study.

To compare the various groups on the basis of percentage of names in W. W. A. an adjustment should be made for differences in age. The number of names included in W. W. A. from a given group will increase as the average or median age of the group increases, other factors remaining the same. The average age of engineers when admitted to W. W. A. is stated to be about 52 years. The average age of engineers included in W. W. E. is somewhat less than this.

In what follows median ages will be used rather than average.

Note: This table should be read as follows: 37 or 8.2 per cent of the teachers in Who's Who in Engineering have had post-graduate work but no advanced degree, etc.

The median age and per cent listed in W. W. A. for each group is as follows:

| Group | Median Age in Years | Per Cent of Group in W.W.A. |
|---|---|---|
| 1. Teachers | 47½ | 27.6 |
| 2. Former teachers | 47 | 22.1 |
| 3. Consulting engineers | 49½ | 18.8 |
| 4. Executives | 48½ | 17.5 |
| 5. Remainder | 44½ | 8.0 |

The median age of the first four groups is 48½ years and the median ages of the individual groups are within 1½ years of this age. The median age of Group 5 however, is four years less than that of Groups 1 to 4. An attempt was made to adjust the per cent of Group 5 in W. W. A. to compensate for this difference in the following way: There are 108 names of individuals in Group 5 who are listed in W. W. A. A cumulative percentage-age curve was prepared by plotting the per cent of these individuals who are a given age or younger. Assuming that the number of names included in W. W. A. as the group grows older increases in accordance with this curve, one may obtain the corresponding increase in percentage of names in W. W. A. by comparing the ordinates of this curve for ages 44½ and 48½. This procedure gives an "adjusted" percentage of names in W. W. A. which is approximately equal to the corresponding percentage for the executive group, and indicates that the reason for the low percentage of names in W. W. A. from Group 5 is primarily due to age differences. No attempt was made to adjust the other groups for age differences on account of lack of sufficient data.

Table 6 shows the relation between educational achievement and

TABLE 6

RELATION BETWEEN EDUCATIONAL ACHIEVEMENT AND INCLUSION OF NAMES IN WHO'S WHO IN AMERICA BY GROUPS

Figures are group percentages from Table 4

| Group | (1) Having had Post-Graduate Work | (2) Membership in Tau Beta Pi or Phi Beta Kappa or in Both | (3) Membership in One or More of the Three Honor Societies | (4) Professional Degrees | (5) In Who's Who in America |
|---|---|---|---|---|---|
| 1. Teachers (449 names) | 54.1 | 35.6 | 51.9 | 30.7 | 27.6 |
| 2. Former teachers (244 names) | 50.8 | 21.7 | 42.2 | 21.3 | 22.1 |
| 3. Consulting engrs. (351 names) | 26.4 | 16.8 | 25.9 | 17.4 | 18.8 |
| 4. Executives (274 names) | 21.2 | 11.7 | 23.3 | 16.8 | 17.5 |
| 5. Remainder (1356 names) | 21.7 | 15.0 | 21.4 | 18.5 | 8.0 |
| 6. Entire group of graduates (2613 names) | 30.0 | 19.2 | 28.7 | 20.5 | 14.5 |

*Note:* This table should be read as follows: Of the 449 teachers in W.W.E., 54.1 per cent have had post-graduate work, etc.

inclusion of names in W. W. A. by groups. It will be noted that the order of rank of the percentages in each of the five columns is very nearly the same.

Figure 2 shows these results graphically. The per cent of names in W. W. A. is plotted against educational achievement for each of

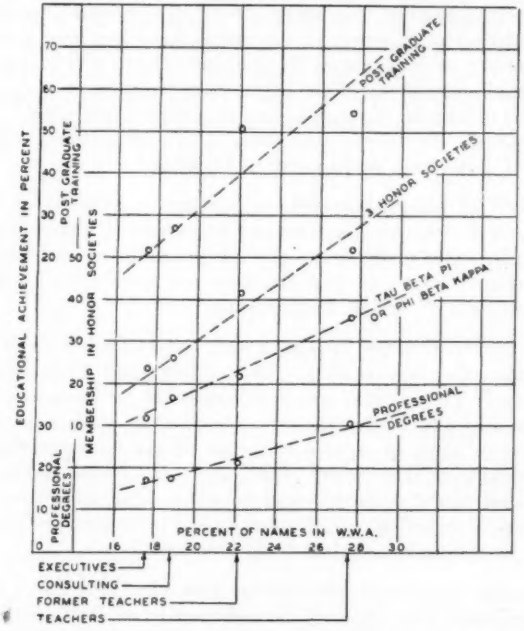



FIG. 2. Relation between educational achievement and inclusion of names in W. W. A. by groups.

the first four groups. There appears to be a tendency towards a linear relation between achievement and inclusion of names in W. W. A. for these particular groups but one would hardly be justified in assuming that this same relation would hold for any group of engineers that might be selected, and one is certainly not justified in concluding from these data that post-graduate work, membership in honor societies and professional degrees generally lead to inclusion in W. W. A. in individual cases.

## CONCLUSIONS AND COMMENTS

In interpreting the above data one should bear in mind the criterion of eminence which was chosen for this study, namely,

inclusion of one's name in Who's Who in America. Other methods of selecting eminent engineers might lead to different conclusions as to the bearing of post-graduate training and scholarship on the achievement of eminence. From the data here presented, however, the following rather definite conclusions seem to be warranted:

1. Generally speaking, the more years of academic training the members of a group of engineers have had the greater the number of individuals in that group who will reach professional eminence. This holds true to a greater degree for post-graduate than for undergraduate training. Of the graduate engineers who have attained eminence 49.4 per cent have had post-graduate training.

2. A record of high scholarship in college or promise of achievement in research increases one's chances of distinction in the engineering profession. Of the graduate engineers who have attained eminence 45.1 per cent are members of Sigma Xi, Tau Beta Pi or Phi Beta Kappa.

These conclusions are in accord with those of other studies based on earnings after graduation. Thus Bridgman [1] found that good scholarship is a significant index of success in business and White [1] concludes that chemical engineering graduates with post-graduate training earn more in certain branches of the industry than those with no post-graduate work. Bridgman also found for graduates of the Land Grant Colleges that there is some advantage in the way of higher earnings for post-graduates over those without such training in occupations other than business.

3. Comparing the five special groups into which the 2,613 graduate engineers were divided, the percentage of distinguished individuals in any given group corresponds with the degree of post-graduate training and scholarship of the individuals in that group as measured by group averages. Teachers stand highest in the list with former teachers a close second. Of the three other groups, consulting engineers, high executives and the remainder, there is little to choose from when allowance for age differences is made.

The executive group is lower in scholarship and in post-graduate training than the consulting engineers but the difference is slight. The rank of the executives, in per cent of eminent men, might be above that of the consulting group if proper allowance were made for age differences in these two groups. All five groups have a higher average of post-graduate training than the general average of older graduates as found from other studies.

One would perhaps expect to find teachers first on the list on this basis but the question arises as to why former teachers as a group are a close second. Is it because of their teaching experience? From the above data it would appear that the reason is rather because of their exceptional training and intellectual capacity. Furthermore in view of the present day interest in engineering education and the increasing development of facilities for post-graduate training the results seem to point to the conclusion that in the future the most distinguished positions in the engineering profession will be occupied to a still greater extent by men of exceptional educational training and natural ability.

## INTRODUCTION TO BUSINESS AND INDUSTRY

By JOHN R. BANGS, JR.

Director of Personnel, College of Engineering, Cornell University

A new course, Introduction to Business and Industry, has been established at Cornell, in the College of Engineering. This course, we feel, has solved a vital problem which has given us a great deal of concern for several years.

Why did we feel that such a course was desirable, and what were our justifications for establishing it? We wonder whether any one of us in the colleges and technical schools is satisfied that our graduates are given sufficient preparation for the radical transition from college thoughts and ways to those of the business world. Up to this year, we have never been even reasonably satisfied. Our view of the situation ran along about as follows:

What activities do most of our students enter after they graduate? They go into some sort of business.

What are we doing, and is it all we can do, to prepare them for the new problems they are about to meet? What are our obligations, in this respect, toward our undergraduates? Are we satisfied to go no further than we seem obligated to go?

Since education should fit one for life, it follows that the education we give our undergraduates should be fairly broad. We have striven toward that end, endeavoring to help each student toward his two main objectives; living and earning a living.

Probably it would be extremely difficult for any one to demonstrate that there is any obligation on any teacher or educational institution to fit each student completely for a certain job and to help him to secure it. It would be even more difficult to demonstrate that we should make each student understand what new conditions he will probably meet in business, as well as what adjustments he must make in his ways of thinking, if he is to progress with relatively few set-backs and discouragements.

Is it not fortunate that whatever we accomplish along these lines gives us the greater satisfaction that follows voluntary creative effort? As our greatest satisfactions come through our achievements, we may well ask: What are our greatest achievements? There can be only one answer for an active teacher or administrator—helping our students to prepare themselves well for living and for earning a living. However, in order to live in the broadest

sense, our graduates must attain reasonable financial success. It follows, naturally, then, that we can increase our satisfaction in the contemplation of our achievements by preparing our students for their coming radical transition from college to industry.

These ideas have had a strong hold upon us for several years. They have been responsible for taking the writer into industry during summer vacations. They have led him to read everything he could find that might help him better to understand each undergraduate and graduate who consults him. These men are hungry for information that will help them to analyze themselves and their own potentialities, and will acquaint them with those activities of business life in which they should stand the best chance to succeed. But the summer experiences of an educator are, at best, limited. It is evident that those who have served in industry are best equipped to give information about business and business ways.

We have been struggling for years with this problem of bridging the gap between college and industry. One move was the establishment of our "Non-Resident Lecture Course." A number of men, well known in their own fields, coöperated with us by explaining in these lectures some of the "high spots" of their several industries. These talks were very helpful from the viewpoint of furnishing general descriptive information. However, there is much other ground that these lectures did not cover, and we asked ourselves many times: "Just what course can we establish for seniors that will give them a clear understanding of the problems they will have to face when they leave college and enter the business world?" Out of these discussions and conferences has finally been evolved what we feel is at least a partial solution to this vital problem.

Obviously the first task in solving an educational problem, dealing directly with the student body, is to find a good teacher and it seemed in all respects that for a course of this nature the teacher should be directly associated with industry. After some deliberation, we consulted with Mr. Howard L. Davis, Director of Technical Employment and Training for the New York Telephone Company. Mr. Davis aided us in drafting an outline, and consented to lead a major portion of the discussions and to give the introductory lecture. His work was supplemented by Mr. J. H. Bigelow who is associated with him; by our Dean and by our Director of Mechanical Engineering. The class, about 150 electrical engineers and mechanical engineers, met once each week during the first semester and, after the introductory lecture, they were given regular assignments from Mr. Davis' book "The Young Man in Business." Such required reading enabled the class to cover a wide variety of subjects and served as a basis for many valuable discussions.

The students were encouraged to hand in written questions prior to the arrival of the discussion leader of the week. In this way the leader could receive these questions, and think them through prior to the time of the discussion. This proved to be an extremely valuable and stimulating feature, judging by the intensity of student interest and discussion. We feel that for the first time we have learned to know a senior class and to appreciate its problems. The students in turn, judging from their own remarks and reactions, gained a very real picture of what is awaiting them after graduation.

The use of a text book proved a valuable aid, and enabled us to cover a wide range of subjects thoroughly and comprehensively. The subjects were:

What is the value of education?
Selection of the job.
Securing employment.
Plan your own future.
Attitude toward job and supervisor.
Preparation and responsibility.
Writing letters and reports.
The pyramid of organization.
Supervision and leadership.
Business ethics.
Character.
The content of a liberal education.

The comments of the members of the group have convinced us that the course was well worth while. The students were stimulated to ask many interesting and searching questions, both in and out of class. A true insight was thus gained into the minds of a representative senior class. They had, before taking the course, a very confused and vague idea of what was before them. We believe that, in addition to the information they acquired, they now have the foundation of a rational business philosophy, and they know to what sources they can go for further information.

# AN ASPECT OF ENGINEERING ENROLLMENT

By E. DILLON SMITH

270 Convent Avenue, New York City

The enrollment of students in our colleges of engineering presents a rather unusual problem, when focused on the prediction of future trends in enrollment. The prediction of enrollment in an institution is rather uncertain when subjective means are used in making estimate. Certain objective data must be colligated and treated by sound scientific method, to secure reliable enrollment trends. One possible method is to use the country's economic indices to forcast the engineering enrollment.

In a large number of our institutions the registrar makes an estimate of the expected number of students for the next school year. In most cases such estimate is based on the sum of the separate estimates obtained through the college deans, who in turn are given their data by division heads. In all such cases these data have been supplied from subjective material. Such an estimate is to be suspected.

The colligation of certain objective economic data will be shown to give a more significant estimate than that obtained by any subjective method. In using this economic data and coupling it with either national or local enrollment records of the past we will first consider the undergraduate enrollment and follow that with the graduate enrollment.

The progressive enrollment in schools of engineering is increasing at the rate approaching three times the rate of increase in the population of the United States. It is not our present concern whether the profession can absorb such an increase of product from these institutions of learning, but we are concerned with the rate of population increase as a factor of enrollment expectancy. By knowing the regression of the engineering enrollment in the past, and the relation between this enrollment and the population increase, a prognosis can be offered which seems to be valid.

Engineering enrollment trends can be plotted from historical data covering fifty years or more, giving a curved regression line similar to that of the population increase of the United States. But detailed analysis indicates that fluctuations are recorded in the enrollment curve of a somewhat periodic character. There are some economic reasons for this fluctuation of enrollment.

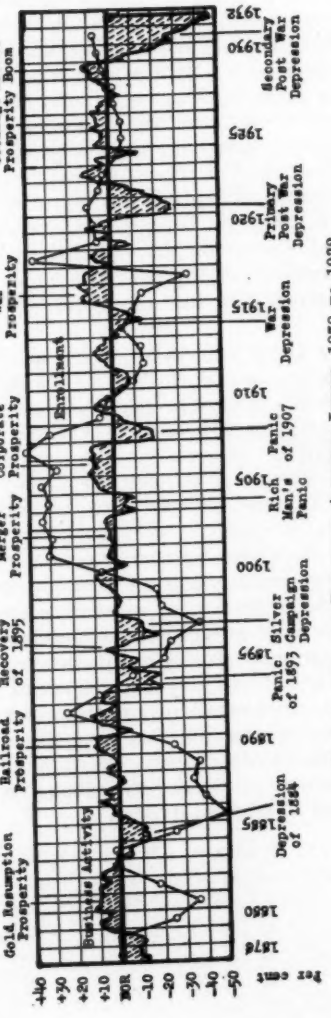
Let us compare this enrollment curve with that of business activity. Business activity data should be plotted over the same period as that used for the enrollment curve. A close relation is to be noted between these two curves.

The accompanying chart of "Enrollment and Business Activity Index" from 1878 to 1932 shows the deviations from normal of the two items represented. The normal condition of business activity has equally balanced periods of inflation and depression over the period shown. Superimposed upon this *Cleveland Trust* index is given the data of the unit fluctuations from the normal expected condition secured from enrollment regression over this same period.

Although these data are taken from only one school, the groups of this sample are of sufficient size to make it significant; the number in the sample being 38,574, taken from data of Dean Anson Marston of Iowa State. The index previous to the War Depression is not as reliable as that shown after this period, for the purpose of indicating trends in enrollment as compared to business activity. The enrollment index has been reduced to a per capita basis. Any variation in the data is statistically non-significant.

The depression of the "70's" found a rather good enrollment of engineers which was followed by a decreased enrollment during the Gold Resumption Prosperity period. The Depression of 1884 brought an increased number of students to college which the Railroad Prosperity period of 1890 reversed. Although the Crisis of 1891 was small, its reaction was felt by an increase in engineering college enrollment. The Panic of 1893 was followed shortly thereafter by the Silver Campaign Depression, with a small recovery intervening in 1895, which sent men to college; but the drain was of such duration that the per cent increase of enrollment did not advance materially, as would be expected from past comparisons. The Merger Prosperity of 1902 and the Corporate Prosperity periods of 1905, with a short Rich Man's Panic intervening between these two periods, resulted in an increase of engineering enrollment which was expected. But, once the market was saturated with men, the normal observed condition returned.

The Panic of 1907 caused a big increase in student enrollment. The recovery after 1907 affected the enrollment until the War Depression of 1914–15, the Industrial Expansion giving man a ready market for his abilities. The War Prosperity period took its toll from the normal rate of increase in the enrollment curve. The Post War Depression sent more than the usual number of men to college; due primarily to the Government's action towards the soldier. A considerable decrease is to be noted during the Coolidge Prosperity and Bull Market periods.




ENROLLMENT AND BUSINESS ACTIVITY INDEX, 1878 TO 1932.

The index for the 1932–33 school year should be slightly higher than that for the year that has just passed. Present business activity indications are pointing towards a decrease next year in the probable enrollment index, or perhaps something less than 1931, but not much less. This assumption is based on the business activity through September of 1932, as shown on the index.

An interesting point of this study is the lagging of the enrollment trend by about one year behind the economic trend. This would seem to indicate that there is close relation between the two items, with the possibility of true objective prediction.

Since the regression of the expected enrollment is known, data secured from price trend or business activity curves can forecast the harmonic amplitude or fluctuation of the enrollment regression curve. As the cause is roughly one year ahead of the actual enrollment, the administration has an objective prediction of future trends.

Much the same trend will follow in the graduate college as in the undergraduate college. Such data as is available indicate that the graduate condition is more pronounced than the undergraduate trend. The men are of a more mature type and take advantage of the opportunity during off-periods to become better equipped intellectually. The regulation of such enrollment should be rather uniform during fluctuation periods, with its control under the personnel service.

It is felt that more investigation is needed upon this problem, to secure many large group samples for an adequate national study of possible scientific prediction of enrollment from associated and affecting factors as they concern the engineering school.

If the enrollment is allowed to run its course, use must be made of statistics to predict future trends. It would seem that certain trends in business administration must be watched to adjust adequately engineering enrollment from time to time. Knowing the trends to be expected in the future, efforts must be made to take care of this enrollment or restrict the number to be admitted according to a battery of selected devices.

## REPORT OF COMMITTEE ON MECHANICAL ENGINEERING

FOREWORD:

The personnel of the Committee on Mechanical Engineering was approved by President H. S. Evans on November 17, 1931. On December 1, 1931, Professors J. W. Haney, J. A. Hall, and the chairman met in New York City on the occasion of the Annual Meeting of the American Society of Mechanical Engineers and discussed preliminary plans for the work of the Committee. On January 20, 1932, active correspondence on the work of the Committee was under way.

PURPOSE:

It is the unanimous opinion of the Committee that there is need for stimulation in the field of Mechanical Engineering in the work of the Society. To this end, the Committee, in the short time at its disposal, has endeavored to formulate certain recommendations to present to the Society for consideration.

RECOMMENDATIONS:

*A.* That the Division of Mechanical Engineering be directed through proper channels to conduct a study of the objectives and courses of study in Mechanical Engineering by gathering the following material:

1. Information on terminologyy, specific needs, and general principles of Mechanical Engineering as is available from the schools.
2. Information on the objectives of the Mechanical Engineering Departments of the various schools.

*B.* That courses of study be examined to ascertain how the objectives are carried out.

DISCUSSION:

These recommendations are the resume of the general opinions expressed by the committee correspondence. They represent the requirements necessary to form the basis for any constructive program in the Mechanical Engineering field of education.

J. A. HALL,
J. R. DUPRIEST,
J. W. HANEY,
F. G. BAENDER,
B. M. BRIGMAN, *Chairman.*

## ENGINEERING: A CAREER—A CULTURE

Through the Education Research Committee, connected with The Engineering Foundation, the national societies of Civil, Mining, Metallurgical, Mechanical, Electrical, and Chemical Engineers and the Society for the Promotion of Engineering Education have prepared a pamphlet which helps to answer our questions. In its pages much is told about what engineers do, and what qualities of mind and character a boy should have to become an engineer. There is information on the schooling that the boy should have and on the engineering colleges; also on the training he should acquire after his schooling is ended and he goes to work.

An engineering education has many uses besides aiding a man to earn a living as an engineer; the pamphlet suggests a few of them.

Teachers in high, preparatory and grammar schools will find this pamphlet helpful as well as boys and parents. Engineers also should have copies. The pamphlet will be revised as frequently as found desirable and made available to persons in all parts of our country year after year.

The pamphlet is being made available through the local sections of the national engineering societies, the colleges and their alumni organizations, and the Society for the Promotion of Engineering Education. Copies can be obtained also from The Engineering Foundation or from the headquarters of the engineering societies in the Engineering Societies Building, New York. In lots of fifty or multiples of fifty, the price is $10 a hundred. For single copies and for lots less than fifty, the price is 15 cents a copy. Orders may be sent at any time; 10 per cent off for quantity orders with cash before December 31st, 1932. Make remittances payable to The Engineering Foundation and send to 29 West 39th Street, New York.

# The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FREDERIC G. HIGBEE, EDITOR

*On Opinion.*—" . . . the drawing teacher has both a great opportunity and a great responsibility. He is generally the first man in the engineering faculty who has any contact with the freshman, unless the school happens to provide a separate orientation course. Whether it does or not, the work of the drawing department gives the student the first introduction to the realities of engineering studies, and whether there is or is not a separate orientation course, one of the major functions of drawing instruction, I believe, is orientation to engineering. It is possible, through the drawing work, either to do an excellent job of orientation or a wretched one; I have seen both done.

Second, drawing work and, in particular, descriptive geometry, are among the best media through which to teach the concepts of space relations, which are important throughout almost all engineering. Therefore, and this point has been covered many times, drawing gives the opportunity of stimulating students' conceptual powers, a function of such importance that it can hardly be overestimated.

Again, drawing work offers the opportunity of a drill in standards of performance—the meeting of specified requirements—and, together with mathematics, gives the student almost his first drill in quantitative as well as in qualitative standards. It combines mental and manual drill, the control of nerves and muscles, which always will be of importance to engineers. It offers the opportunity of providing acquaintance with the things that engineers deal with, machinery, topography, structures, etc. It offers the opportunity of some drill in elementary design and can be used as a means of introducing the student to the methods through which designs are executed. Above all else, it comes early in the curriculum and, together with mathematics, may be used to set the standards to which the students must adhere in all their subsequent work."

—From an address by Professor H. P. Hammond before the Summer School of Engineering Drawing and allied subjects, June, 1930.

## BOOK REVIEW

*Steam Power and Internal Combustion Engines.* CRAIG AND ANDERSON. McGraw-Hill Book Company, N. Y., 482 pages.

The authors devote a chapter to each of the following subjects: Fundamentals of Steam and Internal Combustion Engine Power Plants; Principles of Thermodynamics; Fuels and Combustion; Steam Power Boilers; Stokers and Coal Handling Equipment; Equipment for Burning Pulverized Fuel, Oil, Gas and Wood; Draft Equipment and Air Preheaters; Steam Superheaters and Separators; Feedwater Heating and Treatment; Steam Engines; Special Designs of Steam Engines; Turbines; Condensing Equipment; Pumping Equipment, and Internal Combustion Engines.

The descriptions of equipment are good and unusually well illustrated. The discussions of underlying principles and theory are in parts lacking in clarity, particularly where the authors deal with thermodynamic theory.

L. H.

## NEW MEMBERS

ALBRIGHT, PENROSE S., Assistant Professor of Physics and Chemistry, Southwestern College, Winfield, Kansas. R. A. Seaton, M. A. Durland.

ALDRICH, BENJ. M., Instructor in Mechanical Engineering, South Dakota State College, Brookings, S. D. H. S. Carter, H. M. Crothers.

BARGER, EDGAR L., Instructor in Agricultural Engineering, Kansas State College, Manhattan, Kansas. F. J. Zink, L. E. Conrad.

BRUNIG, MORTON P., Instructor in Agricultural Engineering, University of Nebraska, Lincoln, Nebr. O. J. Ferguson, E. E. Brackett.

DRIFTMIER, RUDOLPH H., Professor and Head, Department of Agricultural Engineering, University of Georgia, Athens, Ga. R. A. Seaton, M. A. Durland.

ERNST, ROBERT C., Associate Professor of Chemical Engineering, University of Louisville, Louisville, Ky. B. M. Brigman, Ruth L. Koch.

FISHER, BENJAMIN A., Associate Professor of Electrical Engineering, Oklahoma A. & M. College, Stillwater, Okla. A. Naeter, V. L. Maleev, C. M. Leonard.

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GINGRICH, RANDOLPH F., Associate Professor of Machine Design, Kansas State College, Manhattan, Kansas. G. F. Branigan, L. E. Conrad.

HUGHES, MARTIN C., Professor and Head, Department of Electrical Engineering, Texas A. & M. College, College Station, Texas. H. M. Dillingham, F. C. Bolton.

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PASLAY, LEROY C., Instructor in Electrical Engineering, Kansas State College, Manhattan, Kansas. R. M. Kirchner, O. D. Hunt.

PERSON, HJALMER T., Associate Professor of Civil Engineering, University of Wyoming, Laramie, Wyo. R. L. Rhoads, R. D. Goodrich.

SITZ, EARL L., Instructor in Electrical Engineering, Kansas State College, Manhattan, Kansas. R. G. Kloeffler, O. D. Hunf.

STRATE, J. T., Professor of Mechanical Engineering, South Dakota State College, Brookings, S. D. H. S. Carter, H. M. Crothers.

TALLMAN, W. D., Professor of Mathematics, Montana State College, Bozeman, Mont. W. M. Cobleigh, R. T. Challender.

TALMAGE, STERLING B., Professor of Geology and Minerology, New Mexico School of Mines, Socorro, N. M. E. H. Wells, J. H. Dorroh.

THERKELSEN, ERIC, Professor of Mechanical Engineering, Montana State College, Bozeman, Mont. W. M. Cobleigh, R. T. Challender.

42 new members this year.